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MISSOURI BOTANICAL GARDEN BULLETIN

Vol. VII JANUARY, 1919 No. 1

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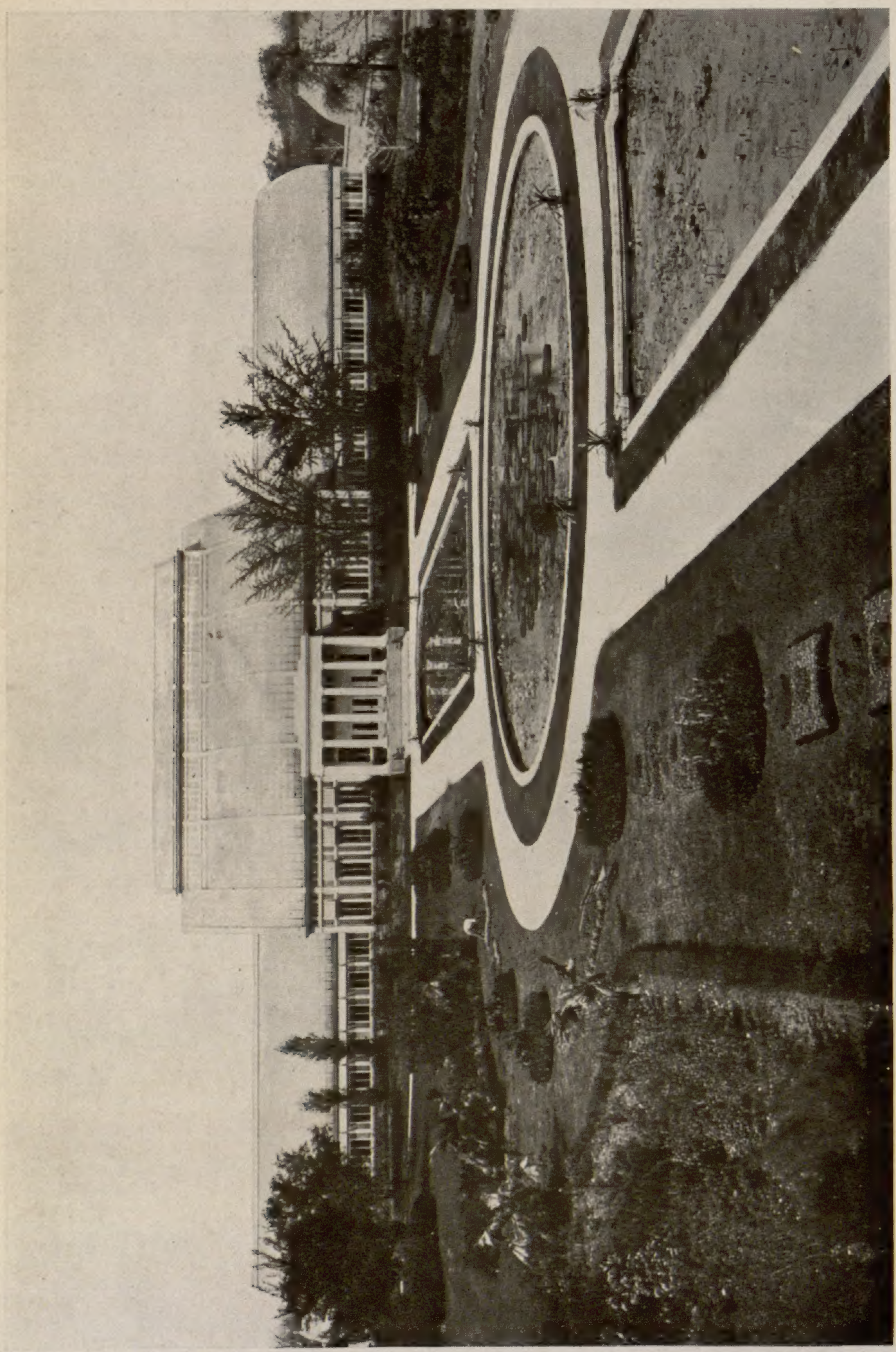

VIEW FROM MAIN GATE.

Missouri Botanical Garden Bulletin

Vol. VII St. Louis, Mo., January, 1919 No. 1

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THIRTIETH ANNUAL REPORT OF THE DIRECTOR

Gentlemen:

I have the honor to submit herewith the thirtieth annual report of the Director.

The year 1918 was necessarily one which permitted but little more than the ordinary maintenance of the regular features of the Garden. Even though it had been possible to obtain the necessary material, the labor situation was such as to prevent undertaking any considerable improvement. In fact, before the year was over, owing to the shortage of labor and the requirements of the Fuel Administrator, one of the most popular features at the Garden had to be discontinued. As a result of the abnormal situation only such improvements were undertaken during the year as seemed to be absolutely necessary. Among these may be mentioned the replacing of the old wooden bridge across the stream in the North American tract with a permanent concrete and stone structure; the reroofing of the lodge house at Cleveland Avenue; the elimination of the walk running from Mr. Shaw's old residence to the economic garden; and the construction of a stone and brick drain the full length of the varied industries house.

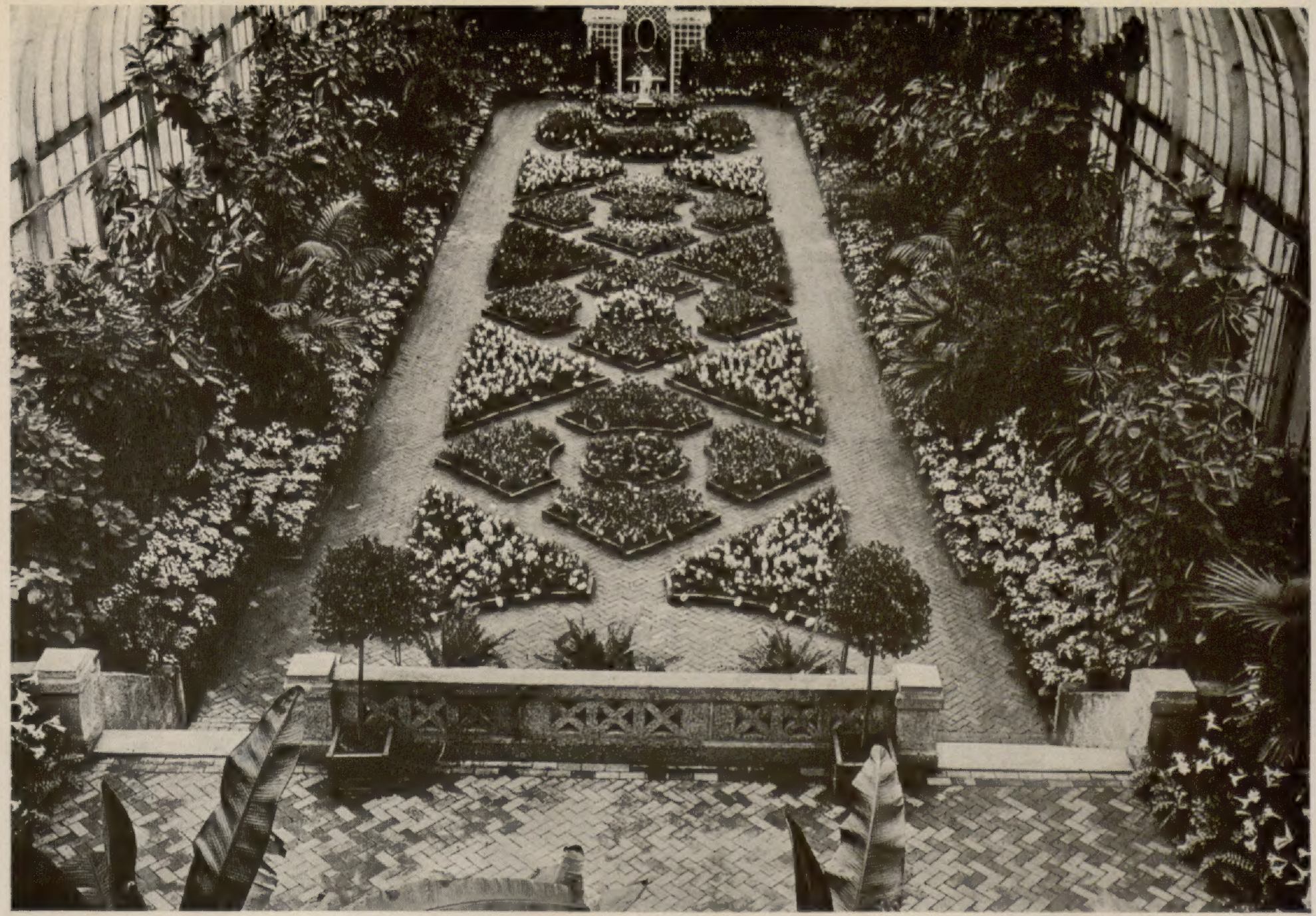
The country residence of Mr. Shaw, which was built in 1849 and is now used for the School for Gardening and storage of herbarium material, was declared, after examination by experts, to be unsafe unless immediate steps were taken to preserve the walls. The building was therefore sand-blasted, after which it became more evident than ever that nothing but stuccoing would save it. The lime and sand mortar had so disintegrated that it was possible to lift out bricks from almost any part of the structure. Since the house as originally built by Mr. Shaw had been surfaced in order to give it a stone effect and it was only after his death that it was painted red, there seemed to be an additional

reason for attempting to restore it to its original appearance. Accordingly, the building has been stuccoed, which will insure its standing for another seventy-five years, besides producing a particularly pleasing effect. As soon as the new planting around the house, together with the vines, becomes established it is believed that the old residence will present a much more attractive appearance than it has in recent years.

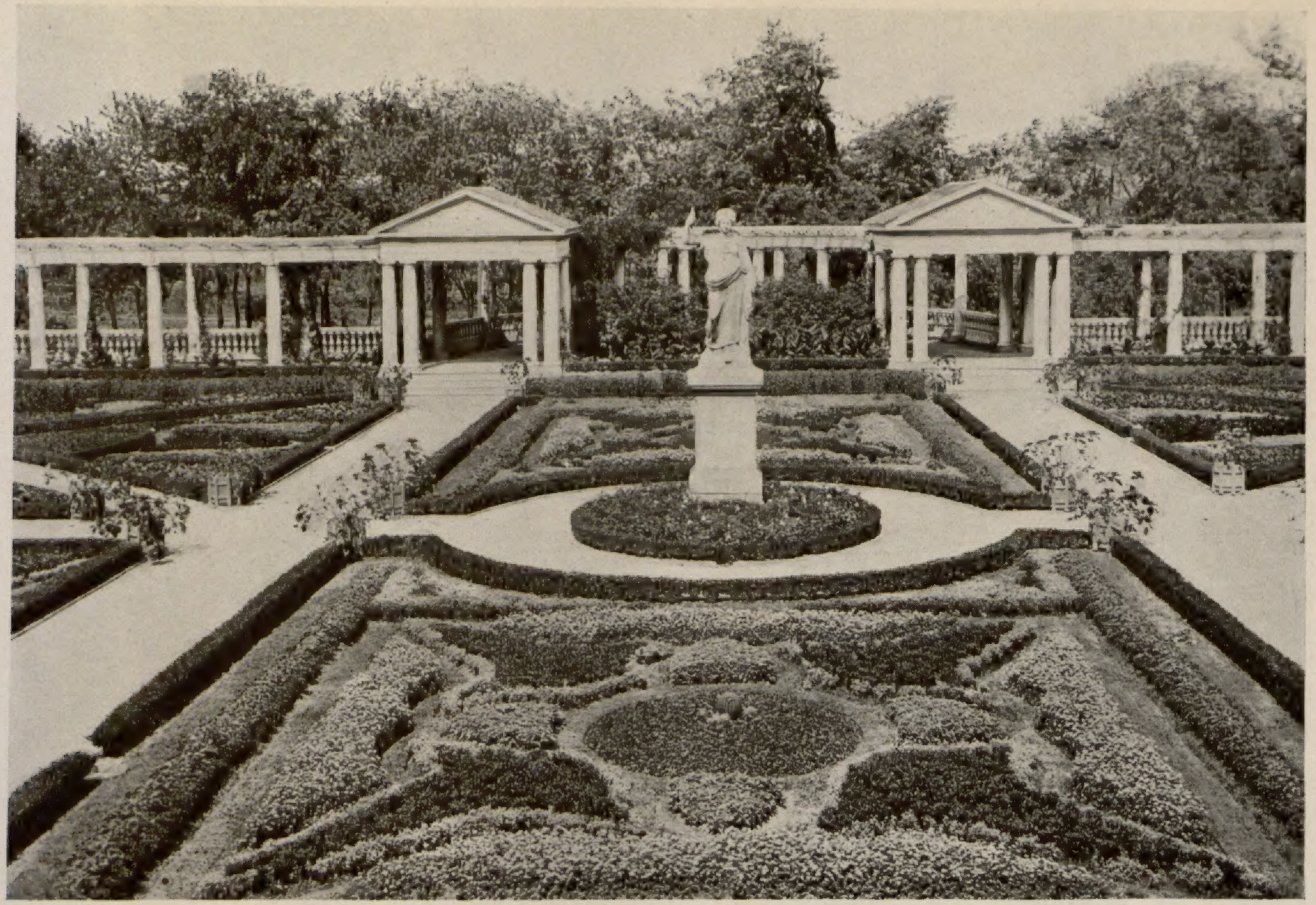
A long-needed improvement has been an exit from the Garden at the south end. Visitors coming in at the main gate and walking through the grounds have been compelled to retrace their steps in order to get out. A turnstile has now been set in the stone wall just north of the gateway at Botanical Avenue, and this, for the present at least, will meet all demands for an exit at this point.

Another addition has been the installation of an overhead watering system in all the display and growing houses where it could be used. This system not only insures a saturated atmosphere during the hot days, but experience has shown that with the fine spray of water it is possible to reduce the temperature of the orchid and other houses from six to ten degrees. It is likewise important as a labor-saver, which, on account of the diminished number of men on the pay roll, has been an important item during the year. In addition to the special items noted above an unusual amount of repair work, particularly painting, both indoors and out, has been attended to during the past twelve months.

The severe winter of 1917-18 resulted in the destruction of a considerable number of plants and trees in the Garden. Some of the hedges were killed, and many of the so-called hardy perennials had to be cut back to the ground. Practically all of the standard roses, together with many other varieties, succumbed more or less completely to the severity of the weather. The greatest single loss was the destruction of all but three of the fine specimens of *Magnolia grandiflora* which had been brought from Florida the previous spring. Although these plants were as thoroughly protected as possible, the fact that they had been in this climate for such a short time, together with the unusual low temperature to which they were subjected, made it impossible for them to survive. Because of the very unusual destruction of permanent plantings in out-of-door gardens, much attention has been paid during the year to replacing this material, and, while it will require some time for the plantations to assume the desired size, in most cases, the substitution of new shrubs will ultimately be a distinct advantage. A large num-



BULB SHOW IN FLORAL DISPLAY HOUSE.



VIEW IN ITALIAN GARDEN.

ber of trees and shrubs were removed from the nursery and used at various points, particularly along the edge of the pasture to serve as a screen back of the pergola, and also along the edge of the Garden bordering on Shaw Avenue. Considerable additions have been made to the collections of iris and hardy azaleas, and other attractive plants have been added in large quantity.

The permanent trellis around the economic garden was planted with a collection of about 100 varieties of vines, in order that the visitor might see good examples of these plants hardy for this vicinity, which were adapted for special purposes.

In addition to the ordinary care of the grounds some progress has been made in filling and grading various points where most needed. The north end of the economic garden is now completed, and the system of walks extending from this point back of the pergola to the north range of greenhouses is now in process of construction.

EFFECT OF THE WAR

Aside from advancing wages, increase in cost of material, and difficulty in obtaining labor and supplies, the most serious effect of the war on the Garden was the order issued last April by the Fuel Administrator, restricting all florists to fifty per cent of the amount of fuel used the previous year. This was interpreted as applying to institutions like the Garden, and, while a special permit was granted which allowed us to obtain the fuel necessary to preserve our permanent collections, it was only upon the condition that we save coal in every way possible and that no annuals or additional perennials be grown in the greenhouses. Accordingly, it was planned to close for the winter all of the growing and propagating houses back of the wall, thus eliminating the winter flower shows in the floral display house, as well as the propagation of thousands of bedding plants which would have been used for outdoor planting next spring. Although the restrictions imposed by the Fuel Administrator were removed late in the fall, it was then entirely too late for the large number of seedlings and cuttings to be obtained, and certainly for the first eight or ten months of the year 1919 the Garden cannot be as attractive from the standpoint of blooming material as it has been in previous years.

WAR ACTIVITIES

As soon as the United States came into the war, the Trustees tendered all of the facilities of the Garden to the Govern-

ment. One of the first organizations to avail itself of this offer was the Red Cross, which was granted permission to establish a surgical dressing shop, the first one to be opened on the south side, in the lecture room of the administration building. A suitable packing room was provided in the basement, and light, heat, janitor service, and other necessities were furnished without cost to the Red Cross. Since the workers in this shop came almost exclusively from the immediate neighborhood, very few of whom had been working elsewhere, there was at once supplied a very considerable addition to the output of the St. Louis chapter.

The following employees of the Garden, together with students in the Shaw School of Botany and the School for Gardening, have been actively engaged either in military or naval service or in war work abroad. Practically all of these are on leave of absence, and it is expected that they will return as soon as they are released from service: C. W. Dodge, Rufus J. Lackland fellow; W. G. Ellis, garden student; G. W. Freiberg, research assistant; Frank C. Harris, garden student; Adam Huber, gardener; Mrs. K. H. Leigh, secretary to the Director; C. McGovern, gardener; R. D. Mitchell, garden student; C. L. Moody, gardener; James Monteith, garden student; E. B. Payson, teaching fellow, Henry Shaw School of Botany; George P. Pedlow, garden student; W. S. Reeves, scientific assistant to the Director; Henry Schmitz, Rufus J. Lackland fellow; and J. W. Severy, teaching fellow, Henry Shaw School of Botany.

Various members of the staff have been associated with war activities in this country as members of such organizations as the Council of National Defense, Raw Products Committee, Food Administration, etc. In addition, the facilities of the Garden have been directed toward solving specific problems as well as furnishing information both along military and commercial lines. The value of the scientific work done at the Garden, together with the great importance of the library, herbarium, and laboratories, has never been so fully manifested, and it is obvious that the business man has begun to appreciate the services which an institution like the Garden can at least render in a practical way.

GIFT OF MR. D. S. BROWN

In April, Mr. D. S. Brown, of Kirkwood, donated to the Garden a considerable portion of his remarkable collection of orchids, palms, etc., and later in the year he likewise gave his magnificent collection of cypripediums. Details of these gifts were given in the BULLETIN for May and November.

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By this means the number of species of orchids at the Garden was more than doubled, and the collection now stands as one of the finest, if not the finest, in this country. In addition to the orchids Mr. Brown turned over to the Garden about 100 palms, including rare species of which there are not more than one or two other specimens in this country. There was also included in the gift about one dozen tree ferns, several of which were unusually large and attractive, and these have added greatly to the beauty of the fern house. It is difficult to express adequately an appreciation of Mr. Brown's generosity. Not since the original founding of the Garden by Mr. Shaw has the institution received a contribution which was so valuable both from the standpoint of its worth in money and its benefit to the people of St. Louis.

ATTENDANCE

While the attendance for the year 1918 promised to exceed that of 1917, the influenza ban, which precluded the possibility of advertising in any way the chrysanthemum show and even necessitated closing the greenhouses on one Sunday in November, so seriously affected the attendance at a time when the largest number of visitors come to the Garden, that for the first time in six years the attendance shows a decrease over that of the previous year. It is also probable that the absence of the indoor Christmas show, necessitated by the order of the Fuel Administrator, likewise had an effect. If the indoor floral displays have been an important factor in the drawing of visitors to the Garden, as appears to be the case, the attendance for the first six months in 1919 may likewise be expected to fall considerably below that of previous years.

ATTENDANCE FOR THE YEAR 1918

	Week-days	Sundays
January	1,583	510
February	3,137	5,341
March	7,223	13,327
April	10,297	13,529
May	10,693	9,509
June	12,484	10,002
July	10,531	8,727
August	11,211	8,067
September	14,183	14,036
October	15,522	11,786
November	6,093	8,111
December	3,100	4,065
	106,057	107,010
		106,057
TOTAL		213,067

ANNUAL BEQUESTS

The Flower Sermon, provided for in the will of Mr. Shaw, was preached in Christ Church Cathedral by the Rt. Rev. John C. Sage, D. D., Bishop of Salina, Kansas, on May 19, 1918.

Instead of the Twenty-ninth Gardeners' Banquet, the Society of American Florists and Ornamental Horticulturists, then in session in St. Louis, was entertained at the Garden on the afternoon and evening of August 22, when a supper was served outdoors.

RESEARCH AND INSTRUCTION

During the past year the facilities for graduate instruction have been improved through the development of better greenhouse equipment and especially through the purchase of devices which may be helpful in controlling humidity and temperature. Chief among the new pieces of laboratory apparatus are a chainomatic balance for analytical work, and a Kober colorimeter. Considerable additions have also been made to apparatus for nitrogen determination.

The number of graduate courses offered during the year 1917-18 was reduced to a minimum on account of the fact that only two new students were registered; but in 1918-19 the work has become practically normal again. Nevertheless, several members of the staff have devoted considerable attention to other scientific and civic work, arising in part as a result of war conditions. The Director has been placed in charge of the Production Division of the Federal Food Administration for St. Louis. He has also been President of the St. Louis Academy of Science, and has delivered a course of lectures in sanitation and hygiene before the S. A. T. C. of the University, also a course in field sanitation before the third-year medical students. Dr. Duggar, in charge of graduate laboratory, has also assumed the duties of acting professor of biochemistry, administering that department during the absence of Professor Shaffer, who has had charge of nutritional work of the American Expeditionary Forces in France. He has also given some time to civic work while chairman of the executive committee of the St. Louis Art League. In addition, Mr. Lurie, Horticulturist, has given considerable attention to the work of conservation and production of vegetables in the vicinity of St. Louis. As a result of the type of contact just mentioned, the amount of correspondence has greatly increased, and undoubtedly the interest in various phases of garden work has correspondingly developed.

Scientific and Extension Lectures.—The following are the more important given by members of the scientific and Garden staffs during 1918:

B. M. Duggar, January 1, before the Brooklyn Institute of Arts and Sciences, "The Significance of Plant Diseases and the General Problems of Parasitism."

B. M. Duggar, February 4, before the St. Louis section of the American Chemical Society, "Some Refinements in the Indicator Method of Hydrogen-Ion Determinations."

G. H. Pring, February 20, before the St. Louis Natural History Museum Association, "Insect Pollination in Flowers."

George T. Moore, March 4, at Graham Memorial Chapel, Washington University, "Vegetable Gardens: Their Use and Misuse."

Alexander Lurie, March 6, before the St. Louis Gardeners' Club, "Tree Surgery."

Alexander Lurie, March 8, before the Wellston High School, "Thrift Gardens."

B. M. Duggar, March 11, at Graham Memorial Chapel, Washington University, "Production and Food Values."

George T. Moore, March 12, before the St. Louis Garden Club, "Lawns."

Alexander Lurie, March 18, at Graham Memorial Chapel, Washington University, "How to Plant."

W. S. Wells, March 18, at the Carnegie Library, Belleville, "Thrift Gardens."

Alexander Lurie, March 25, at Graham Memorial Chapel, Washington University, "How to Plant."

Alexander Lurie, April 3, before the St. Louis Association of Gardeners, "Diseases and Insects Injurious to Thrift Gardens."

G. H. Pring, April 3, before the St. Louis Association of Gardeners, "Vegetable Planting."

Alexander Lurie, April 4, before the East St. Louis Civic Association, "Trees."

W. S. Wells, April 9, before the Bryan-Mullanphy Parent-Teachers' Association, "Thrift Gardens."

George T. Moore, April 13, before the Town Club, "Gardening."

B. M. Duggar, December 10, before the St. Louis Garden Club, "Food Constituents from the Soil and Their Use in the Plant."

Graduates, Fellows, and Investigators.—The number of graduate students qualifying for work and accepted during 1917-18 was limited by war conditions, and it represents the

smallest number accommodated for a period of years. There were registered for graduate work during the calendar year eleven students, as follows: W. W. Bonns, formerly Rufus J. Lackland research fellow; Anne W. Davis, formerly research assistant; C. W. Dodge, formerly Rufus J. Lackland research fellow; Lucy D. Foote, teacher, St. Louis Public Schools; Adele Lewis Grant, teaching fellow, Washington University; Joanne L. Karrer, teaching fellow, Washington University; Alexander Lurie, horticulturist, Missouri Botanical Garden; R. A. McGinty, Rufus J. Lackland research fellow; Takashi Matsumoto, laboratory assistant; E. B. Payson, formerly teaching fellow, Washington University; and R. W. Webb, Rufus J. Lackland research fellow. In addition, there have been in residence, using the facilities of the laboratory in research: Dr. E. R. Allen, associate in biochemistry, Washington University School of Medicine; Dr. S. M. Zeller, special research assistant, Yellow Pine Association; and Emily Schroeder, research assistant.

For 1918-19 only two appointments were made to Rufus J. Lackland fellowships, and these were as follows: R. A. McGinty, B. S. Alabama Polytechnic Institute, assistant professor of horticulture, Colorado State College; and R. W. Webb, B. S. Clemson College.

Other appointments were as follows: Emily Schroeder, A. B. Washington University, 1918, research assistant; Joanne L. Karrer, B. S. University of Washington, 1915, M. S. University of Washington, 1916, teacher of biology and chemistry in Puyallup High School, 1918, teaching fellow, Washington University; Adele Lewis Grant, B. S. University of California, 1902, teacher at Fresno Normal Summer School at Huntington Lake, California, teaching fellow in Washington University; and Takashi Matsumoto, B. S. Tohoku Imperial University of Japan, instructor in natural sciences, Rikkyo High School, Japan, M. S. University of California, 1918, laboratory assistant.

During the year the graduate students who terminated their connection with the Garden after receiving degrees, or in order to enter civilian or federal service, are as follows: Dr. W. W. Bonns, to accept an appointment as research plant physiologist with the Eli Lilly Drug Co., Indianapolis, Indiana; Dr. C. W. Dodge, now sergeant, Sanitary Corps, U. S. A., Camp Devens, Massachusetts; Anne W. Davis, now with the Eastman Kodak Company, Rochester, New York; and E. B. Payson, now in Machine Gun Company, 89th Division, France.

At the commencement of Washington University, June

13, the degree of Doctor of Philosophy was conferred upon W. W. Bonns, with a thesis on "Etherization of Tissues and Its Effect on Enzyme Activity"; and on C. W. Dodge, with a thesis, "Tyrosin in the Fungi: Its Chemistry and Methods for Its Study."

Publications and Papers.—In the following list are included the titles of all papers published during the year by members of the staff and graduate students as a result of investigations and observations made in the laboratories, library, herbaria, and garden. No small part of the investigations completed remain unpublished, due in part to the large amount of time which has been devoted to other duties arising as a result of war-time conditions.

Bonns, W. W. "Etherization of Tissues and Its Effect on Enzyme Activity." Ann. Mo. Bot. Gard., 1918.

Burt, E. A. "Corticiums Causing Pellicularia Disease of the Coffee Plant, Hypochnose of Pomaceous Fruits, and Rhizoctonia Disease." Ann. Mo. Bot. Gard., 1918.

Burt, E. A. "The Thelephoraceae of North America, IX and X." Ann. Mo. Bot. Gard., 1918.

Duggar, B. M. "Botany." Am. Year Book, 1918.

Duggar, B. M. [Twenty-three abstracts of physiological articles in] Bot. Abstr., 1918.

Duggar, B. M., and Bonns, W. W. "The Effect of Bordeaux Mixture on the Rate of Transpiration." Ann. Mo. Bot. Gard., 1918.

Greenman, J. M. "Monograph of the North and Central American Species of the Genus Senecio—Part II." Ann. Mo. Bot. Gard., 1918.

Greenman, J. M., and Pfeiffer, Norma E. "A New Selaginella from Mexico." Ann. Mo. Bot. Gard., 1918.

Lurie, Alex. "The Use of Wild Plants in Ornamental Planting." Jour. Internat. Gard. Club, 1918.

Lurie, Alex. "Tree Surgery." Jour. Internat. Gard. Club, 1918.

Lurie, Alex. "How to Succeed with Fall Planting." Gard. Mag., 1918.

Moore, G. T. "Algological Notes. III. A Wood-Penetrating Alga, Gomontia lignicola, n. sp." Ann. Mo. Bot. Gard., 1918.

Payson, E. B. "Notes on Certain Cruciferae." Ann. Mo. Bot. Gard., 1918.

Pring, G. H. "Cycads." Jour. Internat. Gard. Club, 1918.

Pring, G. H. "Water-lilies." Jour. Internat. Gard. Club, 1918.

Zeller, S. M. "Correlation of the Strength and Durability of Southern Pine." Ann. Mo. Bot. Gard., 1918.

Zeller, S. M. [Three abstracts of physiological articles in] Bot. Abstr., 1918.

Zeller, S. M., and Dodge, C. W. "Gautieria in North America." Ann. Mo. Bot. Gard., 1918.

Zeller, S. M., and Dodge, C. W. "Rhizopogon in North America." Ann. Mo. Bot. Gard., 1918.

The two following papers were presented during convocation week of the American Association for the Advancement of Science before the Botanical Society of America and Section G of the Association, at Baltimore, December 26 and 27:

Duggar, B. M. "Some Factors in Plant Physiological Research."

Moore, George T. "Botanical Participation in War Work."

In the paragraphs below are given brief indications respecting the nature and significance of the investigations completed and published during the year:

Bonns, W. W. (Ann. Mo. Bot. Gard. **5**: 225–299), as a result of a study extending over two years, has made a full survey of the literature relating to the etherization of plants and its effect on enzyme activity. At the same time he has conducted extensive experiments on the effect of etherization on metabolism as expressed by the action upon the activity of diastatic, proteolytic, and catalase-like enzymes extracted from the bulbs of Gladiolus and from the germinating seed of barley. The results indicate no constant stimulation of enzyme action as a result of etherization and a definite inhibition of catalase activity.

Burt, E. A. (Ann. Mo. Bot. Gard. **5**: 119–132) discusses the species of Corticium widely distributed in subtropical and tropical regions, causing the Pellicularia disease of the coffee plant; that causing the Hypochnose of pomaceous fruits in the United States; and the form so widely distributed throughout the world, causing the various types of the so-called Rhizoctonia disease.

Burt, E. A. (Ann. Mo. Bot. Gard. **5**: 177–203) presents a monographic account of the genus Aleurodiscus, resupinate form of Thelephoraceae. This is in fact a genus made up of species related to Corticium and Stereum, but possessing spores of large size and a fructification often much incrusted with granular matter. Fourteen of the twenty-five known species occur in North America. Seven new species are described, and four new combinations given.

Burt, E. A. (Ann. Mo. Bot. Gard. **5**: 301–372). In the tenth contribution of his monograph on the Thelephoraceae of North America the author includes the very important genus Hymenochaete. He brings to light some important

new diagnostic characters and completely revises the American forms. Thirty-six species are described, twenty-nine of which occur from the Gulf States to Brazil. Ten new species are established.

Duggar, B. M., and W. W. Bonns (Ann. Mo. Bot. Gard. **5** : 153–176) have made extensive tests of the effect of Bordeaux mixture upon the loss of water in various plants. The data indicate that while the average water loss of sprayed plants is considerably greater than that of unsprayed plants, this increased loss occurs largely during the night intervals. It is explained on the ground that water loss at this time is related to incipient guttation, and this is further confirmed by the fact that in plants which generally exhibit guttation phenomena transpiration is unaffected by spraying.

Greenman, J. M. (Ann. Mo. Bot. Gard. **5** : 37–108) has continued his monograph of the genus Senecio, and in the present publication presents the tomentose forms, bringing the total number of species thus far discussed to 131.

Greenman, J. M., and Norma E. Pfeiffer (Ann. Mo. Bot. Gard. **5**: 205–210) describe a new Selaginella from Mexico which has been designated *S. Landii*, belonging to the *S. rupestris* group so widely distributed in the United States.

Moore, George T. (Ann. Mo. Bot. Gard. **5**: 211–224) has prepared an account of an alga, *Gomontia lignicola,* a species which penetrates wood. The life history of the form has been followed and the species has proven to be new.

Payson, E. B. (Ann. Mo. Bot. Gard. **5** : 143–151) presents descriptive notes upon twenty species and varieties of North American Cruciferae, the majority of species having been recently collected in the Southwest.

Zeller, S. M. (Ann. Mo. Bot. Gard. **5**: 109–118) presents extensive data showing the correlation of the strength and durability of southern pine, *Pinus palustris,* and proves essentially that the stronger pieces of heart-wood are always the more durable. Strength is related to specific gravity, as previously pointed out, in this case; but this does not apply to sap-wood, where decay is rapid irrespective of specific gravity.

Zeller, S. M., and C. W. Dodge (Ann. Mo. Bot. Gard. **5** : 1–36) furnish a complete account of the hymenogastraceous genus Rhizopogon in North America. Twelve American species are discussed, among which six are new and one a new combination. In addition, they describe fifteen extra-limital forms, among which two are new.

Zeller, S. M., and C. W. Dodge (Ann. Mo. Bot. Gard. **5**: 133–142). Following their discussion of Rhizopogon in North America the authors have naturally turned attention

to other subterranean genera, and the present paper is concerned with a report upon Gautieria in North America. In this genus five American forms are discussed and three extralimital species, only one new species being established.

HERBARIUM

The herbarium has had a normal activity and growth during the year, although few additions have been made in the way of permanent equipment. The installation of much-needed steel cases was discontinued temporarily on account of the high price of steel and the need of this commodity by the Government. The lack of adequate case capacity has resulted in a very considerable congestion in parts of the herbarium and has necessitated much shifting and rearranging of specimens.

New Accessions.—About 150 accessions have been received since the last annual report, and these have included an exceptionally large number of types, co-types, fragments, and photographs of types. Some of the more noteworthy collections acquired are the following: from Arnold Arboretum, 218 plants of Alaska and 486 plants from the Philippine Islands; E. Bartholomew, 200 "North American Uredinales"; Botanic Gardens, Sydney, 350 plants of New South Wales; T. S. Brandegee, 232 plants of Mexico; Bureau of Science, Manila, nearly 3,000 plants of the Philippine Islands; B. F. Bush, 589 plants, chiefly from Missouri; Canton Christian College, 878 plants of China; Judge J. R. Churchill, 124 plants of Massachusetts; Mrs. Joseph Clemens, 447 plants of Oklahoma; College de Longueuil, 374 plants of Canada; Rev. John Davis, 646 plants, mainly from Missouri and South Carolina; J. A. Drushel, 126 plants of the United States; A. D. E. Elmer, 2,146 plants of the Philippine Islands; Dr. W. G. Farlow, 113 fungi of New England, Georgia, and Venezuela; Walter Fischer, 283 plants of South America; F. C. Gates, 517 plants of Michigan and 131 plants of Illinois; Mrs. Adele Lewis Grant, 68 plants of California; J. M. Greenman, 322 plants of Missouri and Illinois; M. T. Greenman, 120 plants of Wisconsin; A. A. Heller, 300 plants of California; A. G. Johnson, 82 plants of Switzerland; P. Jörgensen, 328 plants of Argentina; C. G. Lloyd, 86 fungi from various localities; John Macoun, 104 fungi of British Columbia; New York Botanical Garden, 535 plants, mostly from the West Indies; E. J. Palmer, 6,613 plants of the Southwest; Dr. F. L. Stevens, 77 fungi of Porto Rico; U. S. National Museum, 337 plants, mostly of North

America; Dr. J. R. Weir, 293 fungi of northwestern United States; Dr. Mary S. Young, 146 plants of Texas. A complete list of accessions received may be found in the current numbers of the BULLETIN.

Mounting and Distribution.—The mounting of herbarium specimens has continued through the greater part of the year, and most of the material received has been mounted and inserted in the organized herbarium. Sorting, identifying, and distribution of specimens, particularly those acquired in previous years, has continued throughout the year.

Field Work.—The botanical survey of the Southwest in coöperation with the Arnold Arboretum of Harvard University has been continued; but on account of war conditions and also because of the unusually dry season in the southwestern states somewhat less time has been devoted to field work than in 1917. The Garden collector, Mr. Ernest J. Palmer, has visited numerous localities in Texas, Oklahoma, Arkansas, and Missouri. His itinerary from March 16 to June 30 and again from September 5 to October 12 has included the following stations from which collections were made: Beaumont, Fletcher, Silsbee, Sour Lake, Houston, Velasco, Angleton, Palestine, Riverside, Grapeland, Marshall, San Augustine, Blanco, San Marcos, Uvalde, Chalk Bluff, Palestine, Larissa, Huntsville, Oakwood, Keechi, College Station, Fountain, Bryan, Kerten, Dallas, Uvalde, Barksdale, Crystal City, Byrd, Del Rio, Devils River, Boerne, Austin, Ft. Worth, Baird, Sweetwater, Colorado, Clyde, Post, Canyon, Paloduro Canyon, Gamble's Ranch, Canadian, Channing, Stephenville, Johnsville, Strawn, Denison, in Texas; Muskogee, in Oklahoma; Webb City and Reding's Mill, in Missouri; Cotter, in Arkansas; Branson and Galena, in Missouri; Palestine, Grapeland, Larissa, San Augustine, Uvalde, Chalk Bluff, Smyth's Ranch, Post, Canyon, in Texas; Oklahoma City, in Oklahoma; Texarkana, in Arkansas; Fulton, McNab, and Noel, in Missouri. Most of these stations were visited twice in order to secure, as far as possible, both flowering and fruiting specimens of the early and late-blooming plants. Notwithstanding the dry season, nearly 8,000 specimens were obtained which furnish excellent material for our studies of the flora of the Southwest. Fruit and seeds of a number of plants were collected which can be grown to advantage in the Garden.

Exchanges.—Several important series of herbarium specimens have been received from various institutions and different individuals on the basis of exchange, but no general distribution of duplicate herbarium specimens has been made

this year. A few duplicates, however, have been sent to correspondents.

Use of the Herbarium by Outside Botanists.—A number of visiting botanists have consulted the herbarium from time to time during the year, and this number is increasing. Fewer loans of herbarium specimens have been made this year than in previous years, because it has seemed unwise to risk large shipments of herbarium material under the unusual conditions which have prevailed. Nevertheless, every effort has been made to facilitate the work of specialists who were engaged in monographing technical or difficult groups of plants. Dr. Norma E. Pfeiffer, of the University of North Dakota, spent the greater part of the past summer in the herbarium in continuation of her monographic study of Isoetes; and it is planned to have the results of this study ready for publication some time during the coming year.

Statistical Summary: (For the year ending December 31, 1918.)

Number of specimens acquired on new accessions:		
By purchase	**6,755**	
By gift	**1,703**	
By exchange	**5,179**	
By field work	**6,935**	
Total	**20,572 valued at**	**$2,057 20**
Number of specimens mounted and incorporated:		
From all sources	**12,234 valued at**	**$2,446 80**
Number of specimens discarded from the herbarium	**480**	
Number of specimens in organized herbarium	**832,526 valued at**	**$126,357 85**
Number of specimens in unorganized herbarium (estimated at)	**65,000 valued at**	**5,200 00**
Wood specimens, etc., supplementing the herbarium	**valued at**	**280 00**
Microscope slides, etc.	**valued at**	**410 00**
Total valuation		**$132,247 85**

LIBRARY

In normal times the Garden library receives annually more than 1,500 serial publications containing more or less matter of botanical interest, but the interruptions through the war have reduced this number for the year 1918 to 790. There is record of each number and volume in arrears, and an effort will be made to secure these publications at the

earliest possible moment. A large part of the daily work has been in noting such arrears, checking up and entering the current numbers of publications as they arrive, sending them on the round of the Garden research staff, collating the volumes for the binder, and finally indexing and distributing them on the shelves.

The present year has been exceptional in that there have been no opportunities to purchase books which will complete sets in serials lacking one or more of the earlier volumes.

Reclassification of Books.—Work has been continued during the year, and is now near completion, in making changes in the card catalogue and in the accession slips, which were made necessary by the reclassification, begun in 1915, of the books and pamphlets in the sections of plant physiology and plant pathology.

Publications.—The current volume of the ANNALS OF THE MISSOURI BOTANICAL GARDEN, which is our principal exchange for publications of scientific societies and institutions, contains 377 pages, 17 plates, and 52 text figures, and records the results of botanical researches by individuals connected with the Garden. It is computed that the value per year of exchanges received for the ANNALS is about $1,500. Some exchanges are also received for the Garden BULLETIN. Both the ANNALS and the BULLETIN are supplied to regular subscribers, and separates of the various articles in the ANNALS are for sale by the library. The cash receipts for subscriptions and separates for the year were $368.79.

Loans of Books.—The pressure of war work is shown by the smaller number of loans of books which was made last year to other institutions for use by their investigators. There were loans of 67 books to 27 institutions. Such loans are made on the interlibrary plan. The borrower makes application for the loan through the library of his university, which is responsible for the return of the book in good condition at the expiration of the term and for payment of transportation both ways.

Subject Index.—Work on the subject index of titles of botanical articles published by scientific societies of the world was limited to the classification of cards written in 1917.

Statistical.—There have been 388 volumes, valued at $942.65, and 806 pamphlets, valued at $161.45, donated to the library; and 203 volumes, valued at $723.11, and 53 pamphlets, valued at $19.56, purchased. The library now contains 35,955 books and 46,571 pamphlets, a total of 82,-

526, valued at $123,227.28. There are also 329 manuscripts, valued at $1,605.80, and 930,241 index cards, valued at $9,410.91, and 244 maps, valued at $272.10, making the total estimated value of the library and card catalogue $134,-516.09. A total of 9,312 index cards have been added, of which 1,077 were typewritten by Garden employees, and 8,235 purchased at a cost of $118.29. The number of books bound was 355; 3 manuscripts donated, valued at $2.55; 34 maps donated, valued at $10.50; and 48 maps purchased at a cost of $3.00.

NOTES

Dr. B. M. Duggar, Physiologist to the Garden, has been appointed a member of the Council of the American Association of University Professors.

Mr. Alexander Lurie, Horticulturist to the Garden, has been appointed pathologist for the Society of American Florists and Ornamental Horticulturists for the year 1919.

Dr. B. M. Duggar, Physiologist to the Garden, presented a paper on "Hydrogen Ion Concentration and Bacterial Activity" before the Washington University School of Medicine, January 13.

On January 15, Dr. George T. Moore, Director of the Garden, spoke before the St. Louis Natural History Museum Association at the Public Library, on "The Educational Value of the Missouri Botanical Garden."

Mr. Henry Schmitz, Rufus J. Lackland fellow, who has been in the Naval Reserves since the beginning of the war, has returned to resume his work at the Garden.

Mr. Alexander Lurie, Horticulturist to the Garden, spoke on "Pruning" at the Gardeners' Association of St. Louis, January 8, and gave a lantern-slide talk on "Horticulture" at the meeting of the St. Louis Florists' Club, January 9.

Dr. George T. Moore, Director of the Garden, Dr. B. M. Duggar, Physiologist, and Dr. J. M. Greenman, Curator of the Herbarium, attended the meetings of the Botanical Society of America, at Baltimore, December 26 and 27. Dr. Moore presented a paper on "Botanical Participation in War Work," and Dr. Duggar one on "Some Factors in Plant Physiological Research."

The display of blooming orchids in the aroid house is now at its height. The greater part of the exhibit is taken up by the slipper orchids, of which over 400 plants are represented,

including rare varieties from the D. S. Brown collection. The commercial types of cattleyas are also in abundance, and the unusual white form, *Cattleya Trianae,* is in bloom. *Lycaste Skinneri* and its variety *alba* are in flower for the first time in the Garden collection, while another rare variety, *lasioglossa,* sometimes called the caterpillar orchid, is represented by half a dozen specimen plants. A superb variety of *Vanda caerulea,* with dark blue flowers, is blooming for the first time since its importation from Burma in 1914. Blue is a rare color in orchids, and this plant is judged one of the finest types in the country.

STATISTICAL INFORMATION FOR DECEMBER, 1918

GARDEN ATTENDANCE:

Total number of visitors	7,165

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought	35
Total number of books and pamphlets donated	153

HERBARIUM ACCESSIONS:

By Gift —	
Ellsworth Bethel — *Coleosporium ribicola* and *Cronartium occidentale* from Colorado	2
Mrs. Adele Lewis Grant—Plants of California	68
A. Tonduz—*Senecio* from Costa Rica	1
By Exchange —	
Bureau of Science, Manila, P. I.—Plants of the Philippine Islands	900
New York Botanical Garden—Plants of the West Indies	100
By Field Work —	
J. M. Greenman—Plants of St. Louis County, Missouri	15
Ernest J. Palmer—Plants of the Southwest, namely, Missouri, Oklahoma, Arkansas, and Texas—estimated at	6,613
TOTAL	7,699

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The main entrance to the Garden is located at Tower Grove Avenue and Flora Boulevard, on the Vandeventer Avenue car line. Transfer south from all intersecting lines.

STAFF
OF THE MISSOURI BOTANICAL GARDEN

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MISSOURI BOTANICAL GARDEN BULLETIN

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OF THE MISSOURI BOTANICAL GARDEN

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BARREL SPRAYER.

KNAPSACK AND ATOMIZER SPRAYERS.

Missouri Botanical Garden Bulletin

Vol. VII St. Louis, Mo., February, 1919 No. 2

SPRAYING

Spraying is the practice of protecting cultivated plants from the attacks of insect and vegetable parasites by covering them with substances which have either a toxic or physiologically injurious effect upon the parasitic organism. The damage which is inflicted annually by various injurious insects and fungi is very great and is alleviated to a large extent through spraying. Neglect of this precautionary measure often causes irreparable injury to plants.

Every portion of a plant—root, stem, leaf, flower, fruit, bark, wood—is subject to disease which may be manifested in a number of parts at once. The symptoms of disease are rots, blight, wilt, spots, scab, mildew, rust, smut, yellowing, and canker. To eradicate the diseases indicated by any of these symptoms fungicides are used. A satisfactory fungicide is one that causes no injury to the plant but is effective against the parasites. In addition, it should not be dissolved readily by rain; it should adhere well to plant parts; and in some cases it should be colorless. The various spraying methods employed are: (1) killing of the causal organism as it rests upon the seed; (2) killing of superficial fungi by applying a fungicide to the green parts of the plant; (3) killing of superficial fungi which hibernate upon the bark of dormant plants; and (4) the use of protective sprays.

Killing of causal organism on seed.—For this purpose disinfecting chemicals are applied long enough to kill the organism but not long enough to kill the seeds. Chief among such disinfectants are corrosive sublimate (2 quarts to 15 gallons water); formalin (40 per cent formaldehyde) in the ratio of 1 pint to 30 gallons of water; and copper sulphate.

Killing of fungi on green parts of plant.—This method is applicable to the purely superficial fungi, since internal parasites cannot be reached without injury to the plant. Powdery mildews are the most common examples of such

fungi. The fungicides used are potassium sulphide (1 ounce to 2 gallons of water); Bordeaux mixture (5 pounds copper sulphate, 5 pounds lime, 50 gallons water); ammoniacal copper carbonate (6 ounces copper carbonate, 3 pints ammonia, and 50 gallons water); and flowers of sulphur.

Killing of fungi hibernating on bark of dormant plants.—The sprays for this purpose may be of greater toxicity because of the dormancy of the plants. They are copper sulphate with just sufficient lime to color, and lime-sulphur mixtures.

The use of protective sprays.—Protective sprays are those which are applied to the plant to kill any organism which may fall upon its surface. Bordeaux mixture and ammoniacal copper carbonate are the fungicides most commonly used, and, as they are employed when the plants are in foliage, must be of weaker solution than those used for dormant plants. To be effective the spray must be applied about once every two weeks in order to replace that washed off by rain and to protect the newly appearing surfaces of leaf, twig, or fruit.

The most common types of sprayers are the bucket pumps suitable for use in a garden; the compressed-air sprayers, which are partly filled with the spray mixture, then closed and air pumped in, exerting pressure upon the liquid and forcing it out in the form of a fine spray; the dusters which consist of various forms of bellows or blowers operated by hand, discharging sulphur evenly and economically.

The following table indicates the more common diseases that are eradicated by spraying:

Common Name	Treatment	Frequency
Apple scab	Bordeaux mixture	3–4 times in summer
Asparagus rust	Sulphur	
Carnation rust	Copper sulphate (1 lb. to 25 gals.)	
Celery leaf-spot	Bordeaux mixture	
Chrysanthemum mildew	Sulphur	
Chrysanthemum rust	Bordeaux mixture	5–6 times
Chrysanthemum spot	Bordeaux mixture	
Cucumber powdery mildew	Sulphur	
Currant anthracnose	Bordeaux mixture	5 times
Currant leaf-spot	Bordeaux mixture	5 times
Cyclamen spot	Bordeaux mixture	
Dahlia powdery mildew	Sulphur	
Fern blight	Bordeaux mixture	
Grape powdery mildew	Bordeaux mixture	5–6 times
Grape rot	Bordeaux mixture	5 times

Common Name	Treatment	Frequency
Hollyhock rust	Permanganate of potash (2 tsp. saturated solution diluted in 1 qt. water)	
Lilac powdery mildew.	Sulphur	
Mignonette spot	Bordeaux mixture	
Lettuce downy mildew.	Sulphur	
Onion smut	Formaldehyde treatment of soil	
Palm spot and tip burn	Bordeaux mixture	
Peach curl	Lime-sulphur	
Peach brown-rot	Self-boiled lime-sulphur.	3 times in winter
Potato late blight	Bordeaux mixture	5 times
Potato scab	Bordeaux mixture	5 times
Primrose diseases	Bordeaux mixture	
Privet twig-blight	Lime-sulphur	Early spring
Rose black-spot	Ammoniacal copper carbonate	
Rose powdery mildew	Sulphur	
Snapdragon wilt	Bordeaux mixture	
Tomato leaf-spot	Bordeaux mixture	
Verbena powdery mildew	Potassium sulphide	
Violet leaf-spot	Bordeaux mixture	
Water-lily spot	Soda Bordeaux (effective in removal of algal growth as well)	

The use of chemicals for destruction of insect pests had its origin with the advent of the Colorado potato beetle, about 1870. The spread of this insect was so rapid that it was feared that growing of potatoes was doomed. A trial of spraying the tops with Paris green succeeded so well that it gave rise to the use of chemicals for the control of other rapidly increasing insect pests. At present the methods of control have developed so as to embrace the majority of injurious insects and have relieved the plant world to a certain extent of the depredation caused by these parasites.

The application of chemicals for control is based upon the understanding of the feeding habits of the insects as well as partially upon the life histories and internal structures of their bodies. The insects may be divided into two groups according to their feeding habits—the chewing and the sucking. The former have biting mouth parts constructed to eat the foliage, and usually may be killed by an application to the foliage of stomach poisons. The best of such poisons are Paris green (5 ounces Paris green, 1 pound lump lime, 50 gallons water); arsenate of lead (2 pounds to 50 gallons water); and hellebore (1 ounce to 1 gallon water). Of these, the arsenate of lead is the most

effective, combining strong poisoning and sticking qualities. Hellebore is desirable for short duration use, losing its effectiveness in 4 or 5 days.

The sucking insects derive their food by inserting their beaks through the surface of the leaf, fruit, or bark, and sucking out the internal juices. It is useless to apply a stomach poison for this type, as up to the present time there has been no preparation devised which would penetrate the outer surface of the leaf without injuring the internal tissues. Therefore, the second class of insects must be killed by contact sprays, i. e., by chemicals applied directly to their bodies. The contact poisons include commercial lime-sulphur, kerosene emulsion, and tobacco extract. The kerosene emulsion is prepared by dissolving ½ pound hard soap in hot water, adding 2 gallons kerosene, and later diluting in from 5 to 15 parts of water, depending upon the type of insect and the kind of foliage. The commercial tobacco extract contains nicotine sulphate. The usual dilution of this substance when sprayed is 1 to 500 parts of water or even weaker, depending upon the tenderness of the insect skin.

Advantage has also been taken of the suffocating properties of certain gases for destroying insects, particularly in stored products. These chemicals are known as fumigants. Carbon bisulphide (1 pound to each 100 cubic feet of space) is a fumigant very commonly used. The material to be treated is placed in a tight receptacle or room and the chemical poured into shallow dishes. As the carbon bisulphide is a heavier gas than air, the dishes should be located above the material to be fumigated. Sulphur mixed with lime and painted upon heating pipes also throws off fumes injurious to tender-bodied insects. The most active fumigative agent, however, is hydrocyanic gas, made by combining water, sulphuric acid, and potassium cyanide in the ratio of 3 ounces water, 1 ounce sulphuric acid, and 1 ounce potassium cyanide or sodium cyanide. Fumigation with this gas should be done at night and all plant surfaces should be dry, failure to observe either of these precautions resulting in injury to the plants. The gas is a deadly poison to human beings as well as insects, so that extraordinary caution must be used in its application. Commonly, the water is placed in an earthen vessel and the sulphuric acid poured slowly into it. The potassium cyanide is then wrapped in a piece of cloth and dropped into the vessel, the operator leaving the room quickly. Fumigation with tobacco is now done by the use of specially prepared papers saturated with a solu-

tion of nicotine sulphate. These are twisted in a funnel shape and ignited, producing a thick, suffocating smoke.

Occasionally, substances like lime, tobacco dust, naphthaline, etc., have the power of repelling insects by their odor and are thus effectively used in powder form.

The following table indicates the most common injurious insects, means of identification, and the sprays effective for their control:

Insect	Description	Control
Aphids	Green, red, yellow, black, winged or wingless, soft-bodied insect	Tobacco extract
Bagworm	Larva case made of silk and leaves; female wingless, never leaving bag, where eggs are deposited in spring	Arsenate of lead in spring; removal of bags in winter
Blister beetle.....	Long-legged, black or striped insect, with distinct head and elongated body; emerges from soil in spring	Arsenate of lead
Borer	Flat or round-headed larvae	Probing with wire; protective wash composed of 2 qts. of soft soap dissolved in 3 gals. of water, adding ½ pt. carbolic acid and 2 oz. Paris green, lime added to make thin paste.
Brown-tail moth....	Compact nests hanging during winter; caterpillars appearing before foliage in spring, 1 in. long, brown, marked with row of oblique white dashes on each side of back, two orange spots at hind end	Burn winter nests; spray with arsenate of lead in spring
Canker-worm	Naked measuring worm	Arsenate of lead
Cabbage worm.....	Velvety, green, naked worm	Arsenate of lead in early stage, hellebore later
Cabbage zebra caterpillar	Naked caterpillar, with red head and yellow body striped with black down back and sides	Arsenate of lead
Codling moth.....	Pinkish, fleshy worm which eats cavities within apple	Arsenate of lead just after blossoms fall

Insect	Description	Control
Corn-ear worm.....	1½ in. long, brownish, with spots; skin naked, greasy	Dust with a mixture of arsenate of lead and corn meal (1 tsp. to 1 qt.)
Cottony maple scale	Conspicuous by cottony secretion pushed out from under body of female	10% kerosene emulsion, in spring
Cucumber striped beetle	Yellow-and-black striped beetle	Repellent measures; protection with cloth screens
Cut worm.....	Dark, naked, greasy worm	Paris green mixed with bran and molasses
Fall web-worm.....	Caterpillar, dark-bodied, covered with hair, building web around the terminal shoots	Spray with arsenate of lead; burn webs
Gypsy moth	Caterpillar, 2½ in. long, dark, hairy, with double row of 5 dark spots followed by double row of 6 red spots behind head	Masses of eggs destroyed with creosote; spray with arsenate of lead (6 lbs. to 50 gals.) in spring
Maggot	White, naked, small worm	Disc of tar paper placed around roots, carbon bisulphide poured into hole near plant
Mealy-bug	Soft-bodied bug covered with white powdery secretion	Tobacco extract with addition of alcohol
Oyster-shell scale ..	Small gray scale shaped like an oyster	Lime-sulphur in winter
Potato beetle	Heavy-bodied beetle, with yellow wings marked with 10 black lines; larva red	Arsenate of lead at frequent intervals
Red spider	Reddish mites sucking juices from the under sides of leaves	Forcible water spray; sulphur dusting
Rose slug	Small, slimy, gray larvae of saw-flies	Arsenate of lead
San Jose scale.....	Circular, flat, dark scale with a raised central spot, causing discoloration of inner bark	Lime-sulphur in spring and winter
Squash bug.....	Gray, flat insect with small head	10% kerosene emulsion against young
Tent-caterpillar	Larva 2 in. long, black body with a white line through the middle, and row of blue spots along each side; makes webs in crotches of limbs	Burn webs; spray with arsenate of lead

INGROWN ROCK.

ROOT ACTION UPON ROCK LEDGE.

Insect	Description	Control
Thrips	Dark-bodied, minute, sucking insect, causing discoloration and death of foliage	Spraying or fumigation with tobacco
Tomato worm	Large, naked, green worm with a curved horn near the hind end and seven oblique lines along sides	Arsenate of lead
Tussock-moth	Hairy caterpillar, 1½ in. long, yellow, striped with black, four tufts of white hair on back, black hair at hind end; head bright red with a pencil of black hair projecting on either side	Arsenate of lead
Weevil	Dark-colored snout beetle infecting stored products	Carbon bisulphide fumigation
White fly	White, flying insect, sucking on the under side of leaves	Hydrocyanic gas fumigation

THE INGROWN ROCK

A trip through the rocky hillsides of Missouri reveals many interesting features of the adaptation of plants in general and trees in particular to the environment and media of growth. Plate 6, fig. 1, shows a peculiar specimen of an old bur oak (*Quercus macrocarpa*), with a large limestone rock weighing fully one-half ton imbedded in tissues of the tree. Apparently during the early stages of the growth of this tree, the trunk was wedged tightly against a ledge. The continued pressure of trunk growth against the rock caused a wound, arresting sap activity at this point and forcing the cambium tissue to envelop the rock in its efforts to find proper room for expansion. The tree has finally died, and a portion of it with the imbedded rock has been transferred bodily to a position similar to its natural surroundings in the reconstructed Linnean House.

A feature of more common occurrence, noticeable throughout the various ledge formations, is the mechanical force exerted by the roots of trees in cleavage and elevation of huge rocks. A root reaching a fissure in the rock is able to crack the stone and shatter it by its further thickening. It has been estimated that a weight of two tons may be lifted by growth of a root only ten inches in diameter. According to Kerner and Oliver, this burden is small in comparison

to the weight lifted by the roots of old trees. The large superficial roots which creep over the ground of the forests were not always situated in this position. The underground roots have gradually come to the surface, lifting with them entire trees which often weigh several tons.

The elevation of the trunk may be explained in a simple manner. The first embryonic root growing down vertically into the ground dies off, or its growth is so retarded as to force lateral roots to develop which spread out horizontally in a whorl around the trunk. Similar to the trunk, the roots form successive layers of wood, gradually thickening with age. The pressure exerted by these roots is lateral, compressing the soil below while raising and bursting open that above. In this manner the thickening root gradually emerges to the surface, raising with it the entire trunk. Plate 6, fig. 2, shows the action of a root which has penetrated a fissure in a rock formation, producing the appearance of the tree growing out of solid stone.

NOTES

Dr. Ned Dearborn, of the Bureau of Biological Survey, U. S. Department of Agriculture, visited the Garden recently.

Dr. J. M. Greenman, Curator of the Herbarium, was made chairman of the taxonomic section of the Botanical Society of America, at its recent meeting at Baltimore.

On February 7, Dr. B. M. Duggar, Physiologist to the Garden, presented a paper before the Society of Sigma Xi on "Investigations of 'Ultramicroscopic' Organisms Inducing Plant Diseases."

Corporal C. L. Moody, who has been at Camp Devens, Mass., for the past year, has received his discharge from the Army and has returned to the Garden to fill his former position of foreman of outdoor gardens.

Recent visitors to the Garden include Professor Leva B. Walker, of the University of Nebraska, January 26; Dr. George M. Reed, Cereal Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture; Dr. Charles Thom, Mycologist, Bureau of Animal Industry; and Mr. B. J. Howard, Bureau of Chemistry, February 18.

A number of interesting plants are now in bloom in the various conservatories at the Garden. In the ericaceous house the false holly (*Chorizema ilicifolium*), with its showy masses of orange-red pea-shaped flowers has opened the

season of full bloom. Among the tropical fruits the rose apple (*Eugenia Jambos*), in the economic house, is noteworthy for its white, bottle-brush-like flowers, while the orange and lemon flowers in the varied industries house have filled that conservatory with a pleasing fragrance. The bird-of-paradise plant (*Strelitzia augusta*) which bloomed for the first time in 1918 and of which an account was given in the June, 1918, BULLETIN, is again in flower and may be seen in the palm house.

STATISTICAL INFORMATION FOR JANUARY, 1919

GARDEN ATTENDANCE:

Total number of visitors	8,353

PLANT ACCESSIONS:

Total number of seeds donated	12

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought	41
Total number of books and pamphlets donated	182

HERBARIUM ACCESSIONS:

By Purchase—	
E. Bartholomew—"North American Uredinales," Centuries XX and XXI, Nos. 1901 to 2100, inclusive	200
A. O. Garrett "Fungi Utahenses" Fasc. 10, Nos. 226 to 250, inclusive	25
By Gift—	
Dr. W. H. Ballou—Fungi of New York	5
B. F. Bush—Plants of Missouri, collected by Rev. John Davis	58
Dr. W. H. Emig—Plants of the Arbuckle Mountains, Oklahoma	143
Dr. J. Arthur Harris—Plants of Arizona	75
Dr. J. R. Weir—Fungi of South Dakota and Wyoming	13
Dr. Guy West Wilson—Fungi of South Carolina	2
TOTAL	521

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ROCKERY IN AROID HOUSE.

Missouri Botanical Garden Bulletin

Vol. VII St. Louis, Mo., March, 1919 No. 3

EARLY COLLECTIONS IN THE GARDEN HERBARIUM

The oldest collection of plants in the herbarium of the Missouri Botanical Garden is one which was made about the middle of the eighteenth century and intended to illustrate a work[1] published in 1750. The specimens were collected in the vicinity of Leipzig, Germany, and have been carefully preserved in their original folders accompanied by their original labels; their condition at the present time in every way is quite as good as when first mounted, and, barring untoward accidents such as fire or damage from natural causes over which man has no control, there is no reason why they should not serve indefinitely as a permanent concrete record of the flora of central Europe. The collection is one of the few pre-Linnean herbaria, if not the only one, in America; and it has a historical as well as scientific interest. One of the specimens from this collection is shown in plate 8, and the label accompanying the specimen well exemplifies the method of designating the name of a plant previous to the introduction of the binomial in 1753.

In founding the Missouri Botanical Garden, Mr. Shaw fully realized the advantages of library, economic museum, and laboratories in connection with the study of living plants. Accordingly, in 1857, he commissioned Dr. George Engelmann, who was in Europe at that time, to select such books as were most essential for this purpose and to arrange for the purchase of a large collection of dried plants which had been brought together during the latter part of the eighteenth and the early part of the nineteenth century by Professor John Jacob Bernhardi in Erfurt, Germany. The selection of books was made and the Bernhardi herbarium purchased through the cordial coöperation of Dr. Engelmann. Thus the library and herbarium of the Missouri Botanical Garden were started in the same year.

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[1] BOEHMER, G. R. Flora Lipsiae indigena. *8vo. pp. 340.* Leipzig. 1750.

John Jacob Bernhardi was born in 1774 and died in 1850. He was one of the leading botanists of his time and professor of botany at the University in Erfurt, the environs of which have been long renowned as a center for the cultivation of rare and choice plants. Professor Bernhardi was for some years editor of the *Allgemeines deutsches Garten-Magazin* and also of the *Thuringische Garten Zeitung,* two garden magazines which did much to popularize the study of plants throughout central and southern Europe. It is evident that these connections brought him in close touch with the leading botanical gardens in Europe as well as with the general botanical activities of the day, since we find in the Bernhardi herbarium many specimens of plants which were grown from 1790 to 1830 in several of the continental gardens, particularly in Göttingen, Berlin, Halle, Hamburg, Hanover, Madrid, etc. Many of these plants were of exotic origin, having been raised from seeds collected in foreign countries.

It will be recalled that the latter part of the eighteenth and the early part of the nineteenth century was a period of exceptional activity in scientific exploration and that numerous expeditions were made to various parts of the world, especially to India, South Africa, Australia, Central and South America, China, and the Philippine Islands. Even missionaries to foreign fields not infrequently either sent or brought home with them strange plants from the country in which their missionary work was located.

That Bernhardi was interested in these foreign botanical explorations is shown by the fact that in his herbarium are to be found thousands of plants which were collected in various parts of Europe and in remote parts of the world. A few of the important individual collections that are preserved in the Bernhardi herbarium may be tabulated as follows:

Approximate date of collection	Collector	Country
1772–1775	Thunberg	South Africa
1790	Haenke	Mexico, South America, and Philippine Islands
1799	Rottler	India
1799	Brotero[1]	Portugal
1818	Martius	Brazil
1819	Sellow	Brazil
1820	Moretti	Italy
1824–1827	Bertero	West Indies and Chili
1820	Wallich	India
1830	Salzmann	Brazil

[1] See plate 9.

Tussilago scapo squamato uniflora glabella et
radio regulari. Fl. Lips. 167.
Tussilago Matth. 877. Tab. 1316. J. B. III. p. 593.
Matth. III. 130. Lob. I. 12. f. 1.
—— vulgaris C. B. p. 197. Tourn. 487. Hoerh.
I. 107.
—— Scapo imbricato uniflora foliis subcordatis
angulatis dentatis Hall. Helv. 411. Lon. 50.
Bellium s. Farfara Dod. 332.
Petasites scapo uniflora foliis subtus lanu
ginis Hall. 208.

TUSSILAGO FARFARA L.

EIGHTEENTH CENTURY COLLECTION, ILLUSTRATING BOEHMER'S FLORA OF LEIPZIG, 1750.

SPECIMEN IN BERNHARDI HERBARIUM FROM LUSITANIA (PORTUGAL)
COLLECTED BY BROTERO IN 1799.

Approximate date of collection	Collector	Country
1830	Luschnath	Brazil
1830	Blanchet	Brazil
1830	Sieber	Australia, Mauritius, Martinique and South Africa
1826–1834	Drége	South Africa
1829–1850	Ecklon and Zeyher	South Africa
1827	Weigelt	Surinam
1828	Schiede and Deppe	Mexico
1828	Poeppig	Chili
1835	Wiest	Egypt
1835	Cuming	Philippine Islands
1835–1839	Schimper	Arabia and Abyssinia
1842	Hostmann and Kappler	Surinam
1843	Robert Fortune	China

To American students the collections of Thaddeus Haenke, a Bohemian naturalist, who made a scientific expedition from Europe to the west coast of South America, stopping in Peru and Mexico, thence northward to California, and then to the Philippine Islands, where a prolonged stay was made, is of particular interest. The plants secured by Haenke in the Philippines constitute one of the first large collections from the archipelago; they were studied by Presl[1], also a Bohemian botanist, and, many of them being new to science, were described and illustrated in a large two-volume folio work which was published in Prague, where the first set of these plants was deposited. Next to the series at Prague the set preserved in the Bernhardi herbarium is probably the most complete in existence. A later and considerably larger collection of plants from the Philippine Islands is one made by Cuming in about 1835. The total number of specimens secured by Cuming is said to have been upwards of 130,000. Of these there is a splendid series in the Bernhardi herbarium, and a partial list of them was published by Vidal[2] in 1885. Recent investigations on the vegetation and the economic resources of the Philippine Islands have necessitated repeated reference to these two collections, and their value for the purposes of comparative study cannot well be overestimated.

The botanical work of some of the early missionaries is by no means a negligible quantity. One of the men of this group who made a worthy contribution to our knowledge of the flora of the orient was Rottler[3], a missionary to India

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[1] Presl, C. B. Reliquiae Haenkeanae. *2 vols. folio.* Prague. 1825–35.

[2] Vidal y Soler. Phanerogamae Cumingianae Philippinarum. *8vo. pp. 217.* Manila. 1885.

[3] Rottler. Botanische Bemerkungen auf der hin- und rückreise von Trankenbar nach Madras mit Anmerkungen von Professor C. L. Willdenow. Gesell. Naturf. Fr. Neue Schr. 4 : 180–224. 1803.

late in the eighteenth century. He became much interested in the flora of that country, and the results of his observations are recorded in an article published in 1803 with notes by the well-known botanist Willdenow. How many of Rottler's plants, which were collected between Trankenbar and Madras, are in the Bernhardi herbarium it is impossible to say, but one of them, a plant collected on the 25th of September, 1799, the original or type specimen of *Trianthema triquetra,* has been found.

It has been a pleasure also to find another early collection of plants from India in the Bernhardi herbarium, namely, that of Wallich from the independent state of Nepal. In connection with these collections from the far east that of Robert Fortune should receive more than passing mention. Mr. Fortune collected extensively in China, particularly in the maritime province of Fokien, and his collections to a very great extent form the basis of an excellent flora of China by two well-known English authors, Forbes and Hemsley[1].

The flora of Australia is represented in the Bernhardi herbarium by a large series of specimens collected by Preiss in 1840 and also by plants distributed through Sieber at about the same time. The Preiss plants were critically studied by Lehmann[2], and a detailed account of them was published in two octavo volumes. Both these collections are repeatedly cited in the standard work on the flora of Australia by Bentham and Mueller[3].

Botanical exploration in South Africa at no time has been more actively pursued than during the period to which has been referred. Thunberg[4] was one of the first to explore the country botanically, and his collections served as the basis for one of the early floras published of the Cape region. Perhaps the largest individual collection of South African plants ever brought together was by J. F. Drége, an assiduous collector, between the years 1826 and 1834. His collections are said to have numbered some 200,000 specimens, including many duplicates. From 1829 to 1850 Ecklon and Zeyher were engaged in botanical exploration in South Africa, and their collections also amounted to many thousands of specimens. All these collections, as well as those of Krauss and of Sieber, are copiously represented in the

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[1] Forbes and Hemsley. Enumeration of the plants of China. Jour. Linn. Soc. **23** : 1–521. *pl. 1–14.* 1886–88; **26** : 1–592. 1889–1902.

[2] Lehmann, C. Plantae Preissianae. *2 vols. 8vo.* Hamburg. 1844–47.

[3] Bentham and Mueller. Flora Australiensis. *7 vols. 8vo.* London. 1863–1878.

[4] Thunberg. Flora Capensis. *2 vols. 8vo.* Stuttgart. 1823.

EUPATORIUM CONGLOBATUM DC.

FROM SPECIMEN IN THE BERNHARDI HERBARIUM, COLLECTED IN 1830 BY SALZMANN IN THE STATE OF BAHIA, BRAZIL.

GENTIANA AFFINIS GRISEB.

FROM SPECIMEN IN THE ENGELMANN HERBARIUM, COLLECTED AT "CAMP LITTLE SANDY," COLORADO, AUGUST 8, 1842. FREMONT'S EXPEDITION TO THE ROCKY MOUNTAINS.

Bernhardi herbarium and all are frequently cited in the leading work on the flora of South Africa, begun by Harvey and Sonder[1], portions of which are still in the course of preparation under the direction of Sir David Prain.

Turning now to South America, we find in the Bernhardi herbarium two interesting collections from Surinam, one by Weigelt dating about 1827, and one by Hostmann and Kappler in 1842. How extensive or inclusive the Weigelt collections were the writer does not know, but at least some of them were studied by E. Fries[2] and several species were described by him in 1831. Presumably very few of these plants are in the Bernhardi herbarium. The Hostmann and Kappler collection, on the other hand, is relatively complete, and it was one of the several collections under consideration by Pulle in writing his Flora of Surinam[3]. From Brazil and Argentina we find several important collections in the Bernhardi herbarium, especially those of Martius, Sellow, Salzmann (plate 10), Blanchet, Claussen, and Luschnath. Their collections were made between 1815 and 1840, and the specimens have been critically studied and are cited in a monumental work, namely, Martius, Flora of Brazil[4]. Western South America is perhaps best represented in the Bernhardi herbarium by plants collected by Bertero in 1827 and by Poeppig in 1828.

Of the early collections of plants made in the West Indies, one of the most representative is that of Bertero, which dates back to about 1824. We are fortunate in having in the Bernhardi herbarium a large series of Bertero's plants from Jamaica, San Domingo, Porto Rico, Guadeloupe, St. Jean, and Martinique.

The most noteworthy collection of Mexican plants represented in the Bernhardi herbarium is that of Schiede and Deppe; it is, moreover, of particular interest because many of the plants were new to science and were published in a series of articles by two foreign botanists, Schlechtendal and Chamisso[5], in coöperation with different specialists.

The second large private herbarium, and unquestionably the most valuable one from a scientific standpoint, to be ac-

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[1] Harvey and Sonder. Flora Capensis. 7 *vols. 8vo.* Dublin and London. 1859–1918.

[2] Fries, E. Eclogae fungorum, etc. Linnaea **5 :** 497–553. 1831.

[3] Pulle, A. Enumeration of the vascular plants of Surinam. *8vo. pp. 554.* Leiden. 1906.

[4] Martius, K. F. P. Flora Brasiliensis. *15 vols. folio.* Munich. 1840–1906.

[5] Schlechtendal and Chamisso. Plantarum Mexicanarum a cel. viris Schiede et Deppe collectarum. Linnaea **5 :** 72–174, 206–236, 554–625. 1830; **6 :** 22–64, 352–430. 1831.

quired for the Garden was the private herbarium of Dr. George Engelmann, which was presented by his son, in 1889. The Engelmann herbarium contains many foreign plants, but it is particularly rich in plants collected on the early government surveys in the western and southwestern parts of the United States. Dr. Engelmann's exceptionally active career brought him in close relation with the leading botanists of his time in this country and abroad for a period of approximately fifty years. Moreover, he was constantly exchanging material with co-workers and correspondents, he frequently purchased sets of rare plants for his herbarium, and, like Dr. Asa Gray, he was always fostering botanical exploration in various parts of the United States. His private herbarium numbered approximately 100,000 specimens. It would be impossible in a short article to enumerate all the individual collections represented, but a few of the more important may be mentioned, as follows:

Approximate date of collection	Collector	Country
1838–1842	Wilkes Expedition	South America
1839	Nicollet Expedition	Iowa and northwestern U. S.
1842–1846	Fremont Expeditions[1]	Rocky Mts., Calif., etc.
1848 and 1859	Emory Expeditions	New Mexico
1852	Stansbury Expedition	New Mexico, Calif.
1853	Macey Expedition	Red River
1855	Gunnison and Beckwith Expedition	California
1855	Pope Expedition	Texas
1857	Whipple Expedition	Arizona
1856	Williamson Expedition	California
1873	Hayden Expedition	Colorado
1868	Powell Expedition	Colorado
1858–1859	Simpson Expedition	Nebraska, Utah
1859–1860	Raynolds Expedition	Missouri and Yellowstone Rivers
1873	Wheeler Expedition	Colorado, Arizona
1827–1831	Berlandier	Texas, Mexico
1837	Geyer	Mo. and northwestern U. S.
1843	Kotschy	Kurdistan
1846	Lindheimer	Texas
1842–1847	M. A. Curtis	North Carolina, South Carolina
1846–1849	Dr. J. Gregg	Louisiana, Texas, Mexico
1846	Wislizenus	Mexico
1847	Fendler	New Mexico
1849–1852	Chas. Wright	Texas, New Mexico
1853–1854	Fendler	Venezuela
1860–1864	Chas. Wright	Cuba
1864–1865	Mann and Brigham	Hawaiian Islands
1848–1851	Sir Joseph Hooker	Himalaya
1867	Dr. Ed. Palmer	Arizona
1878	A. H. Curtiss	Florida
1878	Parry and Palmer	Mexico
1833–1880	Dr. G. Engelmann	Ill., Mo., Ark., Col., Calif., etc.

[1] See plate 11.

It is around these two collections, namely, the Bernhardi herbarium and the Engelmann herbarium, that the herbarium of the Missouri Botanical Garden has been built. To these have been added, from time to time, some thirty other private herbaria, together with the current collections acquired by gift, exchange, and purchase, each year since 1889 to the present time.

Thus the Garden herbarium represents a general collection of plants in all groups illustrative of the world's flora, but with a particularly large representation of the flora of the western and southwestern parts of the United States. The herbarium, as a whole, represents a period of botanical activity extending from the middle of the eighteenth century to the present time, or about one hundred and seventy years. It is of especial scientific value because it contains plants from different parts of the world, including many of the older collections from which hundreds of species new to science have been described and numerous published floras have been based. The Engelmann herbarium in particular contains many types which are of fundamental importance in the study of the American flora.

PLANTS IN THE AROID HOUSE

This house is separated into two parts, that containing the collection of araceous plants, and the orchid alcoves. From December until April the orchid alcoves filled with the brilliant coloring and odd forms of the numerous tropical orchids present a most striking appearance. On the opposite side a rockery with its cascades running into a series of irregular pools is thickly planted with representatives of the Araceae recognized by their calla-lily-like spathes. The bright red coloring of the flowers and subsequently the seeds adds a pleasing touch to the large, green, and often highly ornamental foliage. The anthuriums, dumb-cane (Dieffenbachia), spathe flower (Spathiphyllum), false ginger (*Alpinia nutans*), the roots of which are used as a substitute for ginger in India, rattlesnake plant (*Calathea crotalifera*), *Monstera deliciosa,* artillery plant (*Dorstenia Contrajerva*), popping out its ripened fruit in a manner similar to orange seeds when pressed between the thumb and index finger, are some of the interesting features of this house. The concrete wall serves as a support for the tropical climbers, such as philodendrons, shingle plant (*Pothos celatocaulis*), Scindapsus, etc.

Aglaonema acutispathum. **Araceae. China.**
Aglaonema Mannii. **Araceae. Tropical Asia and Africa.**

Aglaonema pictum. Araceae. Malaya.
Aglaonema pictum compactum. Araceae. Tropical Asia and Africa.
Aglaonema Treubii. Araceae. Celebes.
Alocasia javanica. Araceae. Africa.
Alocasia metallica. Araceae. Africa.
Alpinia nutans. Zingiberaceae. India.
Anthurium sp. Araceae. South America.
Anthurium Andraeanum. Araceae. South America.
Anthurium Andraeanum alba. Araceae. South America.
Anthurium Andraeanum salmoneum. Araceae. Colombia.
Anthurium Andraeanum × *Dechardii.* Araceae. G.H.
Anthurium Bakeri. Araceae. South America.
Anthurium carribea. Araceae. South America.
Anthurium cordatum. Araceae. South America.
Anthurium cordifolium. Araceae. South America.
Anthurium crassinervium. Araceae. South America.
Anthurium cristallinum. Araceae. South America.
Anthurium cristallinum × *Ferrierense.* Araceae. G.H.
Anthurium cristallinum variegatum. Araceae. South America.
Anthurium Dechardii. Araceae. South America.
Anthurium digitatum. Araceae. South America.
Anthurium distachium. Araceae. South America.
Anthurium × *Ferrierense.* Araceae. G.H.
Anthurium Ferrierense × *Dechardii.* Araceae. G.H.
Anthurium Galeottii. Araceae. South America.
Anthurium Hookeri. Araceae. Tropical America.
Anthurium hybrid. Araceae. G.H.
Anthurium hybridum. Araceae. South America.
Anthurium insigne. Araceae. Colombia.
Anthurium leuconeuron. Araceae. South America.
Anthurium magnificum. Araceae. Colombia.
Anthurium nymphaeafolium roseum. Araceae. Venezuela.
Anthurium Olfersianum. Araceae. South America.
Anthurium ornatum. Araceae. South America.
Anthurium regale. Araceae. Peru.
Anthurium Regnellianum. Araceae. South America.
Anthurium roseum. Araceae. South America.
Anthurium rubrinervium. Araceae. South America.
Anthurium splendidum. Araceae. South America.
Anthurium Scherzerianum. Araceae. Guatemala.
Anthurium tetragonum. Araceae. South America.
Anthurium undulatum. Araceae. South America.
Anthurium Veitchii. Araceae. South America.
Anthurium Warocqueanum. Araceae. Colombia.
Aphelandra aurantiaca. Acanthaceae. Mexico.
Calathea sp. Scitaminaceae. Tropical America.
Calathea crotalifera (Rattlesnake plant). Scitaminaceae. Tropical America.
Calathea Lietzei. Scitaminaceae. Brazil.
Calathea Makoyana. Scitaminaceae. Brazil.
Calathea princeps. Scitaminaceae. Tropical America.
Colocasia neoguineensis. Araceae. Tropical America.
Cyclanthus cristatus. Cyclanthaceae. Tropical America.
Dieffenbachia amoena. Araceae. Tropical America.
Dieffenbachia Bowmannii. Araceae. Central and South America.
Dieffenbachia Carderi. Araceae. Tropical America.
Dieffenbachia imperialis. Araceae. Tropical America.
Dieffenbachia Leopoldi. Araceae. Tropical America.
Dieffenbachia magnifica. Araceae. Venezuela.
Dieffenbachia Parlatorei marmorea. Araceae. Tropical America.

Dieffenbachia picta Bausei. Araceae. Tropical America.
Dieffenbachia picta brasiliensis. Araceae. Tropical America.
Dieffenbachia Seguine. Araceae. West Indies.
Dieffenbachia Seguine picta. Araceae. Tropical America.
Dieffenbachia splendens. Araceae. Colombia.
Dieffenbachia velutina. Araceae. Central and South America.
Dorstenia Contrajerva. Urticaceae. Tropical America.
Dracaena glomerata. Liliaceae. Congo.
Dracaena Godseffiana. Liliaceae. Congo.
Dracaena × *Mandaeana.* Liliaceae. G.H.
Dracaena Sanderiana. Liliaceae. Congo.
Dracaena Shepperdii. Liliaceae. South America.
Fittonia Verschaffeltii. Acanthaceae. Peru.
Hedychium Horsfieldii (Butterfly lily). Scitaminaceae. Tropical America.
Heliconia Bihai. Scitaminaceae. Mexico.
Heliconia brasiliensis. Scitaminaceae. South America.
Hemigraphis colorata. Acanthaceae. Java.
Homalomena argentea. Araceae. Tropical America.
Homalomena costata. Araceae. Tropical America.
Homalomena rubra. Araceae. Tropical America.
Homalomena Seismeyeriana. Araceae. Colombia.
Homalomena Wallisii. Araceae. Colombia.
Hoya carnosa (Wax plant). Asclepiadaceae. Australia.
Ilysanthes grandiflora. Scrophulariaceae. North America.
Ludovia crenifolia. Cyclanthaceae. Brazil.
Maranta Kegeljani. Scitaminaceae. Tropical America.
Maranta leuconeura. Scitaminaceae. Tropical America.
Maranta ornata. Scitaminaceae. Tropical America.
Maranta Sanderi. Scitaminaceae. Tropical America.
Maranta zebrina. Scitaminaceae. Tropical America.
Medinilla magnifica. Melastomaceae. East Indies.
Monstera deliciosa. Araceae. Tropical America.
Nepenthes sp. Nepenthaceae. Australia.
Nepenthes × *Amesiana* (*Rafflesiana* × *Hookeriana*). Nepenthaceae. G.H.
Nepenthes × *Balfouriana.* Nepenthaceae. G.H.
Nepenthes Curtisii. Nepenthaceae. Borneo.
Nepenthes × *cylindrica* (*distillatoria* × *Veitchii*). Nepenthaceae. G.H.
Nepenthes × *Dicksoniana* (*Rafflesiana* × *Veitchii*). Nepenthaceae. G.H.
Nepenthes × *Dominii* (*Rafflesiana* × *gracilis*). Nepenthaceae. G.H.
Nepenthes × *Dyeriana* (*mixta* × *Dicksoniana*). Nepenthaceae. G.H.
Nepenthes × *Finlayana.* Nepenthaceae. G.H.
Nepenthes formosa. Nepenthaceae. Asia.
Nepenthes gracilis. Nepenthaceae. Borneo.
Nepenthes × *Hainanensis.* Nepenthaceae. G.H.
Nepenthes × *Hamiltoniana.* Nepenthaceae. G.H.
Nepenthes × *Henryana* (*Hookeriana* × *Sedenii*). Nepenthaceae. G.H.
Nepenthes hybrida (*khasiana* × *gracilis*). Nepenthaceae. G.H.
Nepenthes × *intermedia* (*gracilis* × *Rafflesiana*). Nepenthaceae. G.H.
Nepenthes × *Mastersiana* (*sanguinea* × *distillatoria*). Nepenthaceae. G.H.
Nepenthes × *Mastersiana purpurea* (*sanguinea* × *distillatoria*). Nepenthaceae. G.H.
Nepenthes × *mixta* (*Curtisii* × *Northiana*). Nepenthaceae. G.H.
Nepenthes × *paradisae* (*Phyllamphora* × *Hookeriana*). Nepenthaceae. G.H.
Nepenthes Phyllamphora. Nepenthaceae. Asia.
Nepenthes Rafflesiana. Nepenthaceae. Borneo.
Nepenthes rufescens. Nepenthaceae. Australia.

Nepenthes × *Williamsii* (*Sedenii* × *Hookeriana*). Nepenthaceae. G.H.
Palisota Barteri. Commelinaceae. Africa.
Palisota bracteosa. Commelinaceae. Africa.
Panax fruticosum Victoriae. Araliaceae. Australia.
Paullinia thalictrifolia. Sapindaceae. South America.
Peperomia Sandersii. Piperaceae. South America.
Philodendron sp. Araceae. Brazil.
Philodendron asperatum. Araceae. Tropical America.
Philodendron asperum. Araceae. Tropical America.
Philodendron bipinnatifidum. Araceae. South Brazil.
Philodendron cannifolium. Araceae. Tropical America.
Philodendron eximum. Araceae. South America.
Philodendron Glaziovii. Araceae. Brazil.
Philodendron gloriosum. Araceae. Tropical America.
Philodendron Imbe. Araceae. South America.
Philodendron Mamei. Araceae. Ecuador.
Philodendron Melionii. Araceae. South America.
Philodendron Melionii rubescens. Araceae. Tropical America.
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Philodendron radiatum. Araceae. Tropical America.
Philodendron Selloum. Araceae. Brazil.
Philodendron Wendlandii. Araceae. Tropical America.
Pothos aureus. Araceae. Solomon Islands.
Pothos celatocaulis. Araceae. Borneo.
Schismatoglottis calyptrata. Araceae. Malaya.
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Sericographis Ghiesbreghtiana. Acanthaceae. Mexico.
Spathiphyllum blandum. Araceae. Tropical America.
Spathiphyllum candicans. Araceae. Tropical America.
Spathiphyllum cannaefolium. Araceae. Tropical America.
Spathiphyllum cochlearispathum. Araceae. Mexico.
Spathiphyllum commutatum. Araceae. Tropical America.
Spathiphyllum Dechardii. Araceae. Tropical America.
Spathiphyllum floribundum. Araceae. Tropical America.
Spathiphyllum pictum. Araceae. Tropical America.
Spathiphyllum Wallisii. Araceae. Tropical America.
Spathiphyllum Wallisii × *S. cochlearispathum.* Araceae. G.H.
Stenospermum popayanense. Araceae. Asia and Africa.
Strelitzia augusta. Scitaminaceae. South Africa.
Strelitzia Nicolai. Scitaminaceae. South Africa.
Strelitzia Reginae (Bird of paradise plant). Scitaminaceae. South America.
Stromanthe Porteana. Scitaminaceae. Brazil.
Tacca cristata. Taccaceae. Malaya.
Tacca macrantha. Taccaceae. Tropical region.
Tradescantia fusca. Commelinaceae. Tropical region.
Vitis discolor. Vitaceae.
Xanthosoma Lindeni. Araceae. Colombia.
Zamioculcas Loddigesii. Araceae. Tropics.
Zamioculcas zamiifolia. Araceae. Tropics.

NOTES

Mr. Alexander Lurie, Horticulturist to the Garden, gave a talk on "Vegetable Gardening," March 21, before the Bryan-Mullanphy School.

Mrs. K. H. Leigh, Secretary to the Director, who has been in Marseilles with the American Red Cross for the past year, expects to sail for home April 1.

Dr. William Trelease, Head of the Department of Botany, University of Illinois, spent a week at the Garden recently, consulting the herbarium and library.

At the meeting of the Academy of Science, on March 17, Dr. George T. Moore, Director of the Garden, read a paper on "Some Novel Uses for Sea Weeds During the War."

Recent visitors to the Garden include Mr. L. I. Bushnell, Assistant Horticulturist, College of Agriculture, University of Minnesota, March 3; Mr. A. Bonazzi, Assistant Bacteriologist, Ohio Agricultural Experiment Station, Wooster, Ohio; Dr. C. H. Farr, Horticultural and Pomological Investigator, Bureau of Plant Industry, U. S. Department of Agriculture, March 24.

Volume VI, Number 1, of the Annals of the Missouri Botanical Garden has been issued during the month, with the following contents:

"Some Conditions Affecting the Growth and Activities of Azotobacter chroococcum," E. R. Allen.

"An All-Glass Nitrogen Apparatus," E. R. Allen and B. S. Davisson.

"Arcangeliella, Gymnomyces, and Macowanites, in North America," S. M. Zeller and C. W. Dodge.

"The Use of the Colorimeter in the Indicator Method of H Ion Determination with Biological Fluids," B. M. Duggar and C. W. Dodge.

"Tyrosin in the Fungi: Chemistry and Methods of Studying the Tyrosinase Reaction," C. W. Dodge.

STATISTICAL INFORMATION FOR FEBRUARY, 1919

GARDEN ATTENDANCE:

Total number of visitors	4,891

PLANT ACCESSIONS:

Total number of packets of seeds received in exchange	11
Total number of plants received in exchange	353
Total number of plants and seeds received as gifts	38

PLANT DISTRIBUTION:

Total number of plants distributed in exchange	4

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought	10
Total number of books and pamphlets donated	147

HERBARIUM ACCESSIONS:

By Purchase —

B. F. Bush—Plants of Missouri	498
B. F. Bush — Plants of North America, collected by Chandonnet, Forbes, Greene, and Hapeman	133

By Gift —

Prof. P. J. Anderson—Fungi from Amherst, Mass	13
B. F. Bush—Plants of Missouri, collected by Rev. John Davis	36
B. F. Bush—Plants of Missouri	4
J. A. Drushel—Plants of Missouri and Ireland	12
Dr. W. G. Farlow—*Hymenochaete episphaeria* and *H. tabacina* from Sharon, Mass	2
Dr. L. O. Overholts—Fungi from New Hampshire and Pennsylvania	28
Prof. J. C. Nelson—*Senecio vulgaris* L. from Salem, Oregon	1
E. J. Palmer—*Bergia texana* (Hook.) Seub. from Texas	1
W. H. Snell—*Stereum subcruentum* B. & C. from California	1
Dr. S. M. Zeller—Fungi from Missouri and California	4
TOTAL	733

The Garden is open to the public every day in the year, except New Year's, Fourth of July, Labor Day, and Christmas — week days from 8:00 A. M. until one-half hour after sunset; Sundays from December to April, 1:00 P. M. until sunset, from April to December, 2:00 P. M. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Boulevard, on the Vandeventer Avenue car line. Transfer south from all intersecting lines.

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Physiologist in charge of Graduate Laboratory.

EDWARD A. BURT,
Mycologist and Librarian.

HERMANN VON SCHRENK,
Pathologist.

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Curator of the Herbarium.

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Horticulturist.

G. H. PRING,
Floriculturist.

J. J. COUGHLIN,
Construction.

W. F. LANGAN,
Engineer.

P. FOERSTER,
Farm and Stables

H. VALLENTINE,
Carpenter.

MISSOURI BOTANICAL GARDEN BULLETIN

Vol. VII APRIL, 1919 No. 4

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DAHLIAS ALONG GARDEN WALL.

FIELD OF DAHLIAS.

Missouri Botanical Garden Bulletin

Vol. VII St. Louis, Mo., April, 1919 No. 4

THE DAHLIA

The unusual display of dahlias at the Garden during the summer of 1918 was of such beauty and excellence as to arouse much enthusiasm and has helped to stimulate a revival of the use of this flower. Ordinarily, extremely hot weather is detrimental to the proper development of the dahlia, forcing it to remain practically inactive during the season, its growth beginning usually too late to produce any quantity of bloom before frost in the fall; but last summer proved that the St. Louis climate is not necessarily unfavorable to these plants, and with proper care a fair measure of success may be expected except when prolonged periods of drought or heat occur.

The dahlia, with its great variety of forms and coloring, its dense masses of dark green foliage and brilliant flowers standing out in sharp relief, is a most useful plant for obtaining striking yet harmonious effects. The flowers range from one-half inch in diameter to the size of a huge sunflower; in color from maroon which is almost black to a pure white, including many combinations of tints and shades, in brilliancy rivaling the salvia and in delicacy approaching the orchid.

The small single, red, purple, or yellow flower must have been known in Mexico, its native habitat, long before it was first described by Francisco Hernandez (1615). The next reference to the plant was made by Vitalis Mascondi, in 1657, and in 1787 it was first mentioned as a cultivated flower by de Menonville, a French botanist then in Mexico. Its introduction into Europe was accomplished in 1789 through Vincentes Cervantes, director of the Mexican Botanic Garden, who sent seeds to England, and to Abbe Cavanilles, director of the Royal Gardens at Madrid. Cavanilles succeeded in raising plants which produced single and semi-double flowers. These he described in "Icones et Descriptiones Plantarum" (1791), naming the genus "Dahlia" after a Swedish botanist, Andreas Dahl, and the

species "pinnata" because of the winged leaves. *Dahlia coccinea* and *D. rosea* were later described by him, and the seed sent to the various botanical gardens of Europe.

The first English publication to mention the dahlia was the "Botanical Magazine" which contained a colored plate of *D. coccinea,* in 1804. The cultivation of the plants spread rapidly through the European gardens from that period, the doubleness of the flower gradually increasing until the large ball-shaped "show" dahlias reached their perfection about 1850. From 1860 to 1870 little enthusiasm was expressed, but later a great advance in popularity was effected by the introduction from Mexico of the cactus-like type, *D. Juarezii.* Its elegance of form, diversity of type, size, and delicate coloring gave dahlia culture a new impulse. The crossing of this species with the singles has produced a still more graceful and acceptable form, the peony-flowered dahlia, which now rivals in beauty and popularity the cactus type. In recent years the single dahlias of large size and brilliant coloring have caused a revival of interest in that class, the collarette and anemone-flowered types adding greatly to the already numerous kinds available.

The first American publication on the dahlia appeared in 1839, and the subsequent history of the plant in this country closely resembles that of England in the waxing and waning of its popularity through different periods of development. The species which have played an important part in the production of the present improved dahlias are *D. rosea,* known to the trade as *D. variabilis, D. coccinea, D. Juarezii, D. imperialis, D. excelsa, D. Merckii, D. gracilis,* and *D. pinnata.* Up to the present time approximately 3,000 varieties have been listed by the leading tradesmen.

The dahlia is classified in several distinct groups: single, anemone, collarette, duplex, cactus, decorative, show, peony, pompon, and Tom Thumb.

1. Single.—Open-centered flowers with eight to twelve floral rays in one circle, margins often turned down or back.

2. Anemone.—Flowers with one row of large floral rays like single dahlias, but with disk-flowers producing small, tubular petals.

3. Collarette.—Open-centered blossoms with not more than nine floral rays but with one or more rows of smaller rays, usually of a different color, making a collar about the disk.

4. Duplex.—Semi-double flowers, with center always exposed on opening of bud, and with petals in more than one

TYPES OF DAHLIAS.

PEONY
SINGLE

POMPON
COLLARETTE
SHOW

DECORATIVE
CACTUS

row, long and flat or broad and rounded, not noticeably twisted or curled.

5. Cactus.—A fluted type with double flowers; floral rays long, narrow, incurved or twisted, with sharp divided or fluted points and with rolled-back margins forming in the outer florets a more or less perfect tube for more than half the length of the ray.

6. Decorative.—Double flowers flat, having broad, somewhat loosely arranged floral rays with broad or rounded tips which are straight or decurved, and with margins revolute if rolled at all.

7. Show.—Double flowers globular, full to center, showing regular spiral arrangement of florets; floral rays more or less quilled with markedly involute margins and rounded tips.

8. Peony-flowered. — Semi-double flowers with open centers, the inner floral rays being usually curled or twisted, the other or outer petals being either flat or more or less irregular.

9. Pompon.—Small-flowered, stellate, five-petaled cactus dahlias.

10. Tom Thumb.—Dwarf, bushy, single-flowered dahlias.

CULTURE

The simplicity of its culture, adaptability to soils, and production of numerous flowers make the dahlia a general favorite in climates where atmospheric conditions are moderate. The plant is a perennial but tender to frost, so that it is necessary to lift the roots in the fall, store them during the winter, and plant out in the spring. The planting of entire clumps sometimes leads to failure in producing flowers, the strength of the plant being spent in foliage growth. It is therefore advisable to divide the old clumps, using but a single tuber. As this tuber should contain a part of the collar of the plant where the new buds occur, it is best to wait until buds develop before planting.

The division of the clumps is the most common manner of propagation, but the commercial method is by means of soft-wood cuttings. For this purpose the clumps are removed from storage in February or March and placed upon a greenhouse bench where they are covered with sand or sphagnum moss and kept at a temperature of 60° F. As soon as buds start water should be applied in copious quantities. When the shoots show two to three leaves they are

removed as cuttings and placed in sand with bottom heat. The cutting should be made through a node or just below it to insure proper rooting and development of tubers, two to three weeks usually being required for rooting. Seed propagation is a simple method, but the results are very unsatisfactory due to the hybrid character of the parentage and is not advocated for the amateur except as a means of production of unstable novelties.

The distance apart for planting varies with the varieties, but for general purposes three to four feet are usually left between plants. The time of planting has been a matter of dispute, but there is little doubt that early planting is not as satisfactory as late. To flower properly the wood must be young and succulent, this condition being obtained only through a continuous period of growth without a check. Early-started plants are severely checked by the heat of midsummer and either fail to flower at all or are killed by frost before flowering. Heavy pruning of woody plants may result in sufficient rejuvenation to produce flowers. The last of May or early June is considered the best period for planting.

Light soils are best suited for dahlias, the original home of the genus being the sandy plateaus of Mexico. On very light soils manure or other humus-producing substances should be introduced to improve the moisture-holding capacity, while heavy soils should be lightened by the introduction of sand, lime, sheep manure, or bulky straw manure.

Further treatment of dahlias after planting consists of training them in one of two ways: (1) They may be allowed to develop unrestricted, a stake being driven to each plant to support the stem; or (2) the terminal shoots may be pinched out after three to four pairs of leaves are formed, this checking the terminal growth and producing heavy, stocky stems capable of self-support. This latter process naturally delays the blooming period for two weeks and removes the largest of the flowers, but by judicious disbudding the size of the other flowers may be increased sufficiently to serve all needs.

Thorough cultivation to conserve moisture is essential. A mulch of leaves, grass clippings, or well-rotted manure may be used during the summer for this purpose. Watering should only be practiced if done regularly, the ground being thoroughly soaked at intervals depending upon the weather. Mere sprinkling of the ground is deleterious, though spraying of the tops during particularly hot weather is beneficial.

After a killing frost in the fall, the stems should be cut close to the ground and the tubers carefully dug, avoiding the breaking of necks. After allowing them to dry for a day, the clumps should be stored in a cool, dry place, tops down. If the temperature is likely to rise much above 50° F. or should the atmosphere be too dry, they should be buried in moist sand, fine coal ashes, or sawdust. Excess of moisture should be avoided.

The diseases attacking dahlias are of negligible quantity, the most serious being the powdery mildew, which, however, is readily controlled by spraying with sulphur or Bordeaux mixture.

A little more troublesome are the insect pests. In moist localities slugs are quite common, feeding upon the young shoots and often the buds and leaves. Hand capture at night is a common and successful method, while poisoned bran bait scattered at the base of the plants is quite effective, as is also naphthalene or lime. The tarnished plant bug is a serious pest at certain seasons, blighting or deforming the flower by piercing the bud at its base, or ruining the petals after opening. This small brown active bug is a sucking insect not subject to stomach poisoning and is so alert as to make contact spraying almost impossible. Covering the plants with close-mesh netting may eliminate the pest, which, however, disappears with the advent of cool nights. Red spider, and black and green aphis are readily controlled by contact spraying with nicotine extracts. Borers working in the stalks may be removed without much harm to the plant by splitting the stalk with a sharp knife and killing the insect.

For satisfactory use as cut flowers the blooms should be cut early in the morning or late in the evening. The stems should be placed in deep water in a cool place. The keeping quality may be improved by removing most of the foliage, plunging the stems in hot water and then placing in cold water to which a teaspoonful of salt to the gallon has been added.

The following are some of the best varieties for decoration and cutting which were grown at the Garden in 1918:

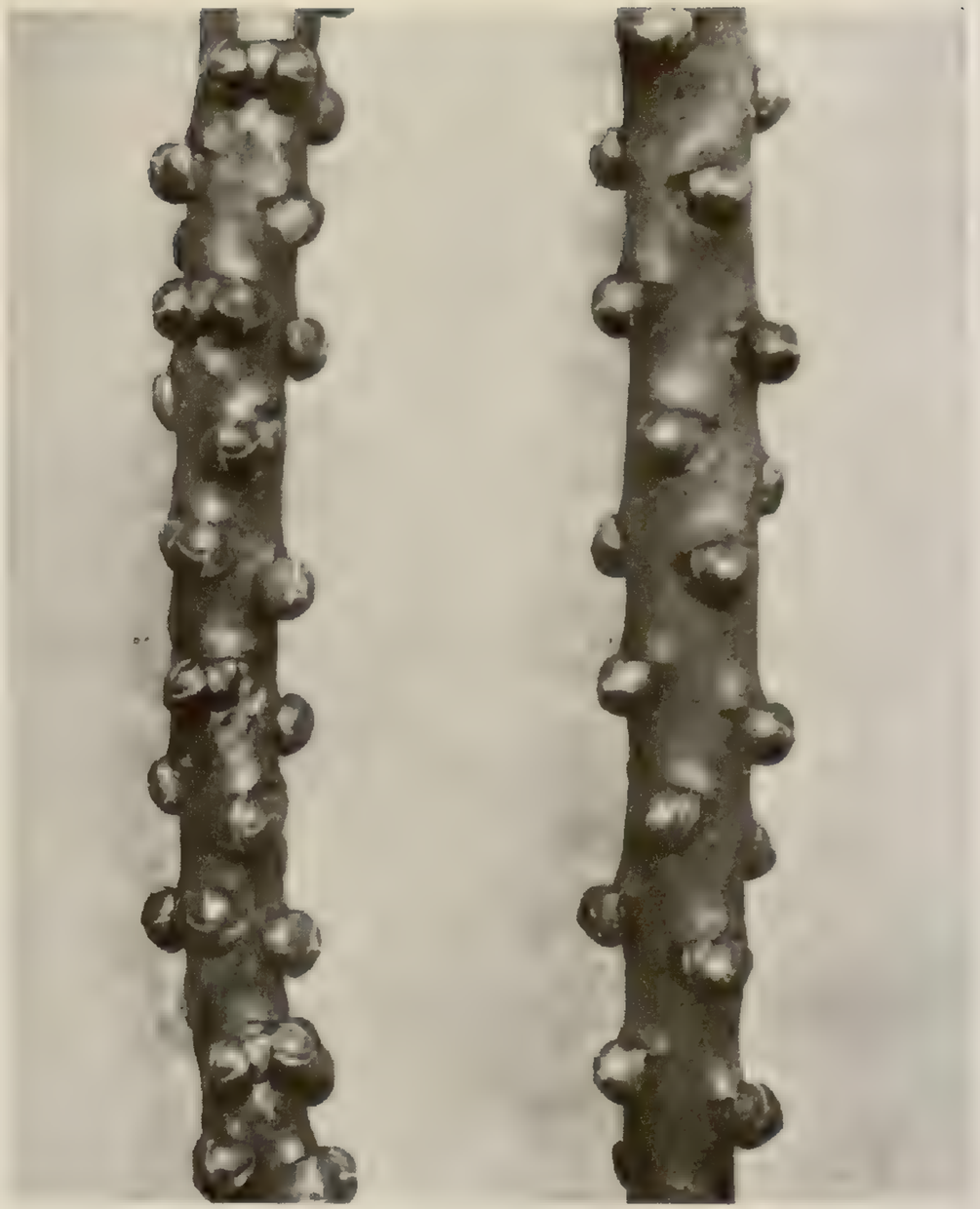
NAME	TYPE	COLOR
A. D. Livoni	Show	Pink
Arabella	Show	White
Auguste Nonin	Decorative	Red
Aurora	Cactus	Reddish apricot
Breezelawn	Decorative	Orange
Caleb Powers	Show	Pink

NAME	TYPE	COLOR
Chas. Lanier	Show	Yellow
Countess of Lonsdale	Cactus	Salmon
Delice	Decorative	Pink
D. M. Moore	Decorative	Dark red
Dorothy Peacock	Decorative	Pink
Etendard de Lyon	Cactus	Pink
Eventide	Decorative	White
F. R. Austin	Peony	Red to cream
F. L. Bassett	Decorative	Purple
Geisha	Peony	Red and gold
Golden Eagle	Cactus	Golden buff
Golden West	Decorative	Yellow
Hampton Court	Peony	Pink
Hortulanus Viet	Decorative	Pink
Jack Rose	Decorative	Crimson
Jeanne Charmet	Decorative	Pink
Kalif	Cactus	Scarlet
Lawine	Cactus	White
Le Grand Manitou	Show	White and red
Marguerite Bouchon	Cactus	Pink
Master Carl	Cactus	Orange
Maurice Rivoire	Collarette	Red and white collar
Miss Minnie McCullough	Decorative	Yellow
Mrs. Roosevelt	Decorative	Pink
Nancy Mae	Cactus	Scarlet
Nerissa	Pompon	Pink
Orange King	Decorative	Orange
Perle de Lyon	Decorative	White
Prairie Fire	Peony	Scarlet
Prof. Mansfield	Show	Yellow
Rene Cayeux	Cactus	Red
Rev. T. W. Jamieson	Cactus	Pink
Rheinkönig	Cactus	White
Selma	Anemone	Pink
Souv. de G. Douzon	Decorative	Orange
St. Louis	Single	Red
Snowclad	Pompon	White
Sylvia	Decorative	Pink
Thuringia	Cactus	Red
Wodan	Cactus	Salmon
Wolfgang von Goethe	Cactus	Apricot
W. W. Rawson	Show	Pink
Yellow Colosse	Decorative	Yellow

FLOWERING PALMS

The flowering and fruiting of palms is commonly observed only in their native habitats, the artificial conditions obtaining in the usual methods of pot or tub culture not being favorable to the production of fruit. This fact makes the many palm specimens in flower or fruit in the palm house at the Garden of particular interest at the present time. The erection of the large conservatories in 1913 afforded the opportunity for the removal of the palm collec-

FLOWERING SPECIMEN OF ARENGA SACCHARIFERA.



PORTION OF FLOWERING SPIKE OF ARENGA SACCHARIFERA.

PHOENIX RECLINATA.

CHAMAEDOREA SP.

tion from tub culture to the more natural one of planting directly in the ground. In the present spacious palm house the roots are not confined, and in consequence of the unlimited supply of food a number of specimens have more than doubled their size. This increased stimulus to roots and foliage has naturally brought about the attempt to perpetuate the species through the medium of flowers and fruit.

In most palms the stamens and pistils are borne on separate flowers, frequently making it difficult to differentiate the sexes. While the individual flowers are generally not showy, the protective covering known as the bracts and the stems supporting the seeds are often highly colored. The seed capsules are sometimes used for ornaments, especially those of imbricated formation like those figured in the September, 1914, number of the BULLETIN (plate 7, figs. 1 and 2).

The most noteworthy specimen in the palm collection flowering for the first time is the giant "toddy palm," *Arenga saccharifera,* presented to the Garden by Mr. D. S. Brown in 1913 (plate 19, October, 1913, BULLETIN). Indications of flowering were noted several months ago by the stunted formation of the terminal leaves, and recently six flower spikes have appeared in succession. The lowest raceme was the first to appear and is bearing twenty spikes of inconpicuous dark green flowers, the spikes measuring four to five feet in length. Upon development of the raceme the globular staminate flowers immediately fall off, leaving the undeveloped pistillate flowers. The arrangement of these flowers is shown in the accompanying illustration (plate 14, fig. 2), the spike at the left showing the staminate flowers on each side of the pistillate flowers, the other showing the pistillate flowers after pollination and dropping off of staminate flowers. This palm is native of the Philippine Islands, where it is known as "ejow" or "gomuti palm." It is the source of native palm sugar, or jaggery, the plant dying after being tapped.

Phoenix reclinata, planted in the extreme northeast corner of the house, is showing several large flower spikes, strongly resembling at a distance the spikes of ornamental grasses. The flowers soon after opening reveal a copious supply of white pollen, which presents a strong contrast to the large, bright scarlet, overhanging bracts. This species is closely related to the common date palm.

The various species of Chamaedorea are showing flowers and fruit, ranging from freshly developed, small yellow flowers to fully matured fruit. The seeds are ornamental,

with their fleshy black glabrous covering, while the supporting spike changes its early green color to that of bright scarlet.

The common southern palm, *Sabal Palmetto,* familiar to visitors from Florida, is bearing two large spikes heavily laden with jet-black seeds.

The Chinese fan-palm, *Livistona chinensis,* twenty-five to thirty feet in height, is showing several spikes of greenish yellow flowers. The leaves of this palm are used extensively in the fan industry.

Pritchardia pacifica, a less common variety, has huge fan-shaped leaves, the under side being covered with a thick white pubescence. The small golden-yellow flower spikes, with white overhanging bracts, are somewhat hidden by the massive leaves.

NOTES

Mr. T. G. Yuncker, of the University of Illinois, spent a week at the Garden recently, consulting the herbarium and library with reference to the genus Cuscuta.

Mr. G. H. Pring, Floriculturist to the Garden, spoke on "Beautification of St. Louis" before the West End Business Men's Association, at the Odeon, April 9.

Mr. Alexander Lurie, Horticulturist to the Garden, gave a talk on "Gardening" at the Rose Fanning School, April 18, and at the Pierre Laclede School, April 21.

The March issue of the Journal of the International Garden Club contained the first of a series of articles on "Plant Curiosities" by Mr. Alexander Lurie, Horticulturist, and Mr. G. H. Pring, Floriculturist to the Garden.

Dr. D. T. MacDougal, Director Botanical Research, Carnegie Institution, Desert Laboratory, Tucson, Arizona, visited the Garden, April 14, and spoke before the graduate seminar on "Investigations Relating to the Carbohydrate Mechanism of the Cell."

Among recent visitors to the Garden were Dr. C. Koidzumi, Professor in the Imperial Japanese Army Medical College and Major in the Japanese Medical Service, and Dr. Hiroshi Nomaura, Assistant Professor of Chemistry in the Tohoku Imperial University, Sendai, Japan, March 27; Mr. K. Yamada, Agricultural Adviser to the Japanese Government, March 28; Mr. M. R. Ensign, Assistant Pathologist, Agricultural Extension Work, University of Arkansas,

April 10; Lieut. W. H. Gerke, City Forester of Portland, Oregon, April 14; Mr. S. M. Dietz, Office of Cereal Investigations, Bureau of Plant Industry, U. S. Department of Agriculture, Ames, Iowa, April 15; Dr. Alfred Nerinex, of the University of Louvain, April 23.

STATISTICAL INFORMATION FOR MARCH, 1919

GARDEN ATTENDANCE:

Total number of visitors	10,731

PLANT ACCESSIONS:

Total number of plants received in exchange	4
Total number of plants and seeds received as gifts	3,576

PLANT DISTRIBUTION:

Total number of plants distributed in exchange	12
Total number of packets of seeds distributed in exchange	62

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought	9
Total number of books and pamphlets donated	184

HERBARIUM ACCESSIONS:

By Gift—

J. A. Drushel—Plants of the United States	14
H. H. Hume—Cultivated specimens of *Ixia leucantha* Jacq. and *I. campanulata* Houtt. from Florida	2
Prof. Lena B. Walker—*Cyathus alba* from Lincoln, Nebr	1
Prof. A. Yasuda—Wood-destroying fungi of Japan	40

By Exchange—

California Academy of Science, by Miss Alice Eastwood—Plants of California	280
Prof. W. L. Jepson—Plants of California	30
Prof. W. L. Jepson—*Senecio* of western United States	11
L. Rodway—*Isoetes* from Tasmania	1
U. S. Department of Agriculture, by W. E. Safford—Photograph of *Cosmos sulphureus* Cav	1
TOTAL	380

The Garden is open to the public every day in the year, except New Year's, Fourth of July, Labor Day, and Christmas—week days from 8:00 A. M. until one-half hour after sunset; Sundays from December to April, 1:00 P. M. until sunset, from April to December, 2:00 P. M. until sunset.

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MISSOURI BOTANICAL GARDEN BULLETIN

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POPULUS ALBA, SHOWING COMPARATIVE SIZE OF TUMOR AND STEM.

Missouri Botanical Garden Bulletin

Vol. VII St. Louis, Mo., May, 1919 No. 5

PLANT CANCER

For several years the appearance of a destructive disease upon the marguerites, or Paris daisy, grown under greenhouse conditions has caused considerable concern among the growers. The same conditions have been observed at the Garden, and it seems desirable to indicate the symptoms and causes of this injurious disease and its possible remedies.

Its occurrence was first noted in Europe about fifty years ago, and its cause variously ascribed to frost injury, fungi, slime moulds, various small animals, and mechanical injuries. The first turn in the right direction was given by Corvo and Cuboni in their contention that the causal organism was bacteria. However, since no definite proofs were presented, it is thought that theirs was a happy guess based upon the resemblance of the tumors to the tubercles of the olive which were caused by bacteria. In 1897 Cavara described a tuberculosis of the grape, and by careful methods of pure culture and successful inoculation of the organism obtained proved bacteria to be responsible for the disease. A tumor of the rose was ascribed in 1903 by Scalia to bacterial origin.

In the United States a number of experiment station workers (Thaxter, Halsted, Selby, etc.) proved the peach gall to be infectious; but it was left to Dr. E. F. Smith, of the Bureau of Plant Industry, to isolate the causal organism and to successfully carry out cross inoculations, thus proving its definite relation to the disease and demonstrating its effects upon numerous plants.

In 1904 a number of white and yellow varieties of marguerites (*Chrysanthemum frutescens*) affected with gall-like growths on leaves and stems were received by the Bureau of Plant Industry. An accompanying statement indicated that both young and old plants were attacked, but that the older were more seriously affected. The appearance of the galls was noted outdoors in the summer and in the greenhouses

during winter. The galls varied from one centimeter in diameter, green and spongy, to several centimeters in diameter, brown, corky, and hard, in the older specimens. After a continuous study of more than two years with more or less negative results, two distinct organisms were isolated and later inoculated into young marguerite plants. Numerous carefully conducted experiments led to the conclusion that one of these organisms (*Bacterium tumefaciens* Smith and Townsend) was responsible for the abnormal growths. Cross inoculations firmly established this point and indicated that the pest varied in its adaptability and virulence in different hosts.

The following table illustrates the appearance of the organism upon different plants subject to its attack and the widespread occurrence of the disease:

PLANT	DESCRIPTION OF TUMORS
Marguerite Chrysanthemum Marigold English daisy	Leaves yellowed at edges; galls on stems green, later corky, brown
Tomato Potato	Slow-growing, hard tumors
Tobacco	Knots ½ inch in diameter formed all over the plant
Beet Radish Carrot	Large irregular tumors on the side of the roots
Grape	Galls on underground as well as aërial parts
Peach Almond	Galls 1–2 inches in diameter occurring at the crown or just below it
Apple Cotton	Galls at crown
Quince	Warty galls on stems, entire limbs often being covered with irregular outgrowths
Raspberry Blackberry Red clover Alfalfa	Galls upon roots
Rose	Large galls at crown and roots
Geranium Castor bean	Large galls, upon stems at nodes, covered with abortive leafy shoots
Shrubs and trees, particularly *Populus alba*, *Castanea dentata*, *Juglans niger*, and *Salix*	Crown galls

CROWN GALL ON POPULUS ALBA.

CANCER ON SNAPDRAGON.

MARGUERITE, SHOWING CROWN GALL ON STEM

The organism is a short rod multiplying by fission and motile by means of polar flagella. It can be grown in many sorts of culture media, forming small, round, white colonies, but does not live very long upon agar. The bacterium differs from others in not forming open cavities in plants but occupying living cells, thus causing proliferation. The galls begin to be visible in some cases as early as the fourth day after inoculation, growing rapidly in soft young tissues and quite slowly upon woody plants. Ready cross inoculation and isolation from plants greatly different in structure indicate that the same organism is probably responsible for the injury. The galls are often invaded by saprophytic bacteria, nematodes, and various fungous parasites. Their size depends upon the state of nutrition of the plant, those overfed being subject to more rapid growth. The long-continued growth which often occurs upon woody tissues is made possible by a nearly even balance between the stimulus of the parasite and the response of the host. The presence of the organism in cells stimulates abnormal growth, resulting in the observed tumors. Up to the present no remedies have been devised, for although the organism is susceptible to germicides, it is impossible to reach it through the outer covering of the gall. Complete removal and burning of affected parts may reduce the prevalence of disease.

The belief has recently been expressed by E. F. Smith that there is a great similarity between the crown gall of plants and malignant cancer of human beings. He claims that since, fundamentally, plants and animals are alike, certain physical and chemical laws apply equally to both, and since plant cancer is caused by a parasite, the same is equally true of animal cancer. The cancer of plants has been found to be caused by a single organism, hence he considers that a single parasite should be looked for in human cancer. Dr. Smith bases his conclusion upon the following resemblances which occur in the course of both diseases: (1) no parasite being visible; (2) the tumor tissues showing rapid multiplication and embryonic character; (3) loss of polarity of these tissues; (4) rapid surface growth of tumor; (5) presence of degenerative changes in proliferating cells; (6) destruction of surrounding tissues; (7) invasion of open wounds by secondary parasites and saprophytes; (8) frequent return after excision; and (9) presence of atrophy.

TEST GARDEN

Many new, interesting, and showy varieties of plants are being constantly added to the list of those which may be

used advantageously in producing pleasing garden effects. While some of these introductions mean nothing more than a change of name and others a mere varietal difference in the manner of growth, color, or shape, a few may really be noteworthy contributions evolved by careful hybridization or selection. In order to test out the novelties as they appear upon the trade-lists of the seedsmen, a test garden has been established at the south end of the Garden where the public may judge for itself the claims and merits of the plants. During the season of 1919 the annuals will be in preponderance.

The following list indicates the contents of the garden:

Acroclinium roseum
Amarantus paniculatus
Antirrhinum majus Halmark, yellow
Antirrhinum majus Halmark, white
Antirrhinum majus Halmark, black
Antirrhinum majus Halmark, scarlet
Antirrhinum majus Halmark, rose
Antirrhinum majus Halmark "White Queen"
Antirrhinum majus Halmark "Golden Queen"
Antirrhinum majus Sutton "Tom Thumb," rose
Antirrhinum majus Sutton "Tom Thumb," white
Antirrhinum majus Sutton "Tom Thumb," crimson
Antirrhinum majus Sutton "Tom Thumb," pink
Antirrhinum majus Sutton "Tom Thumb," yellow
Antirrhinum majus Sutton "Tom Thumb," red and white
Antirrhinum majus "Orange Beauty"
Antirrhinum majus "Feltham Beauty"
Brachycome iberidifolia
Calendula officinalis "Favorite"
Calendula officinalis "Lemon King"
Calendula officinalis "Meteor"
Calendula officinalis "Orange King"
Calendula officinalis "Prince of Orange"
Calendula pluvialis
Calliopsis coronata "Crown of Gold"
Calliopsis coronata "Golden Ray"
Calliopsis coronata "Tiger Star"
Calliopsis Drummondii "Golden Wave"
Calliopsis nigra speciosa
Calliopsis tinctoria
Calliopsis tinctoria, double
Calliopsis atrosanguinea
Callistephus chinensis "Ray"
Callistephus chinensis "Royal"
Callistephus chinensis "Giant Comet"
Callistephus chinensis "Imperial"
Callistephus chinensis "Mikado"
Callistephus chinensis, "Peony-flowered"
Callistephus chinensis "Ostrich Feather"
Callistephus chinensis "Grego Giant"
Callistephus chinensis, single
Callistephus chinensis "Perfection"
Callistephus chinensis "Victoria"

Callistephus chinensis "Heart of France"
Callistephus chinensis "American Beauty"
Celosia Childsii
Celosia cristata nana "Empress"
Celosia cristata, carmine
Celosia cristata, orange-red
Celosia cristata, golden yellow
Celosia plumosa
Celosia Thompsonii magnifica
Cosmos bipinnatus, double crowned
Cosmos bipinnatus, double white
Cosmos bipinnatus "Lady Lenox," pink
Cosmos bipinnatus "Lady Lenox," white
Cosmos bipinnatus "Klondyke"
Cosmos bipinnatus "Ruffled Pink Beauty"
Dianthus chinensis
Dianthus hybrida, pink
Dianthus diadematus
Dianthus Heddewigii, fl. pl.
Dianthus Heddewigii "Dwarf Snowball"
Dianthus imperialis
Dianthus laciniatus, double
Dianthus laciniatus, single
Dianthus mirabilis
Dianthus nobilis
Diascia Barberae
Dimorphotheca aurantiaca
Erysimum Perowskianum
Eschscholtzia californica "Chrome Queen"
Eutoca viscida
Gaillardia Lorenziana
Gaillardia picta "Giant Double"
Godetia gloriosa "Ladybird"
Godetia gloriosa "Scarlet Queen"
Godetia gloriosa "Double Rose"
Godetia gloriosa "Apple Blossom"
Godetia gloriosa "Duchess of Albany"
Godetia gloriosa "Lady Albermarle"
Gypsophila elegans "Paris Market"
Helianthus annuus, red
Helianthus annuus "Albino"
Helianthus annuus "Lilliput Hybrids"
Helianthus annuus, single
Helichrysum bracteatum
Helichrysum monstrosum
Heliotropium grandiflorum
Helipterum Sanfordii
Iberis umbellata "Empress"
Iberis umbellata "Giant Hyacinth"
Ionopsidium acaule
Jacobea sp.
Leptosyne maritima
Leptosyne Stillmanii
Limnanthes Douglasii
Lobelia tenuior
Matthiola incana "Heatham Beauty"
Nemophila atomaria
Nemophila discoidalis
Nemophila insignis grandiflora

Nemophila insignis alba
Nemophila insignis, mauve
Nemophila maculata grandiflora
Nicotiana affinis
Nycterinia capensis
Oenothera Drummondii nana
Oenothera Lamarckiana "Imperial Royal"
Oenothera rosea
Oenothera taraxacifolia alba
Oenothera bistorta Veitchii
Oenothera macrocarpa
Oenothera Fraseri
Oenothera hybrida Sutton "Afterglow"
Origanum sp.
Orthocarpus purpurascens
Papaver Rhoeas
Papaver Rhoeas, double
Papaver somniferum "Carnation"
Papaver somniferum "Snowdrift"
Papaver somniferum "Firedragon"
Papaver somniferum "New Cardinal"
Papaver somniferum "Double Peony"
Papaver somniferum, shrimp-pink
Papaver somniferum, silver lining
Papaver somniferum "Fairy Blush"
Papaver orientale
Papaver glaucum "Tulip"
Petunia hybrida, double
Petunia hybrida, single
Petunia hybrida "Balcony," rose
Petunia hybrida "Balcony," white
Petunia hybrida "Balcony," blue
Phacelia campanularia
Phlox Drummondii
Portulaca grandiflora "Parana"
Rhodanthe maculata
Salvia patens
Salvia splendens "Ostrich Plume"
Salvia americana
Salvia Gardneriana
Scabiosa maxima
Scabiosa maxima plena, golden yellow
Scabiosa maxima plena "Azure Fairy"
Scabiosa maxima plena "Snowball"
Scabiosa maxima plena, royal purple
Scabiosa maxima plena "Fairy Scarlet"
Scabiosa maxima plena, cerise
Silene pendula compacta
Statice sinuatum
Tagetes erecta "Prince of Orange"
Thermopsis caroliniana
Torenia Fournieri grandiflora
Verbena erinoides
Verbena venosa
Verbena "Aurora borealis"
Verbena hybrida "Firefly"
Verbena hybrida "Defiance"
Verbena hybrida striata
Verbena hybrida, yellow

Xeranthemum
Zinnia elegans "Picotte"
Zinnia elegans, violet
Zinnia elegans, curled

DELPHINIUMS

As permanent subjects in the hardy flower garden few plants are more worthy of special mention than the delphiniums. For producing a striking display over a long season they are quite unique, attracting attention by their stateliness as well as their variety of blue shades which run the gamut of all known blues from deep reddish purple to a delicate azure almost indistinguishable from white. In addition, their hardiness and adaptability make them highly desirable for greater use in our gardens and borders. Under our climatic conditions, however, delphiniums seldom equal in size, loveliness of tone, and continuity of bloom those grown in cooler climates of greater degrees of humidity.

Many parts of the world have contributed to our wealth of delphiniums. They have come from Siberia, Formosa, Caucasus, China, California, Rocky Mountains, etc., while numerous hybrids have originated in England and France through the painstaking efforts of Kelway and Lemoine. The old strains have been improved almost beyond recognition from the narrow-petaled flowers crowded together to the well-developed columnar spikes of the present-day hybrids.

CULTURE

In order to alleviate the trying effects of our hot climate upon the cool-loving plants special attention should be given to soil requirements. A well-drained, cool, rich soil should be provided with an abundant supply of moisture during dry weather, especially in the period prior to flowering. After flowering the plants may be cut down to the ground and mulched with well-rotted manure. This treatment will serve the threefold purpose of providing coolness, conserving moisture, and furnishing a second crop of bloom early in the fall. Although exceedingly hardy, delphiniums are benefited by a protective light mulch of well-rotted manure placed about the crowns after the first freezing of the ground. The mulch should be spaded in early in the spring, thus supplying the essential fertility. During winter months delphiniums are often attacked by slugs, with disastrous results, and as a precautionary measure 2 or 3 inches of soil may be removed from the crowns and replaced by very fine

ashes. Large clumps should be divided every three or four years.

Several methods are employed in propagation—division, layers, cuttings, and seed. Division is performed in March when the stems are dormant. The plants are lifted, divided into several parts, and placed in the cold-frames until ready for planting outdoors.

Cuttings may be taken with a heel early in the spring and rooted either in a hot-bed or propagating bench in a greenhouse. Upon rooting the new plants should be potted and later transplanted to the nursery soil or cold-frame in readiness for their final positions in the fall or following spring. Late summer and fall propagation may also be resorted to, though it is not as successful as the spring method. Where greenhouse facilities are available delphiniums may be lifted after freezing, potted, and forced slowly, producing new growth from which cuttings are taken during January or February.

Another successful method is by means of layering which is done in May or June. A cut is made at the extreme base of the stem and covered with fibrous loam. In due time roots will be forced out near the cut and a new plant secured, which can be severed from the parent plant early in the spring.

Seed is sown in the cold-frame late in the summer or in greenhouses early in the spring. In the first case the plants will flower the following summer, in the second case they may flower the same autumn. Care should be exercised in carrying the seedlings over winter in cold-frames to keep them moderately dry and well aerated. Light should be admitted very early in the spring. In selecting varieties for seed clear distinct colors, robust habit, and symmetrical spikes should be chosen.

The following are the more important species of Delphinium:

NAME	COLOR	TIME OF BLOOM	HEIGHT	HABIT	HABITAT
Ajacis	blue, violet	May-Aug.	18 in.	Annual	Europe
altissimum	blue, purple	Aug.-Sept.	3–4 ft.	Perennial	Himalaya
bicolor	blue, yellow	May-Aug.	6–12 in.	Perennial	Colorado
Brunonianum	blue, black	June-July	6–18 in.	Perennial	China
cardinale	red	July-Aug.	3 ft.	Perennial	California
carolinianum	azure-blue	July	2 ft.	Perennial	N. C. to Ill.
cashmerianum	azure-blue	July-Sept.	10–18 in.	Perennial	Himalaya
cheilanthum	yellow	June-July	2–3 ft.	Perennial	Siberia
decorum	blue	May-July	6–18 in.	Perennial	California
elatum	blue, violet	June-Aug.	2–3 ft.	Perennial	Europe

NAME	COLOR	TIME OF BLOOM	HEIGHT	HABIT	HABITAT
exaltatum	blue, yellow	June-Aug.	2½ ft.	Perennial	Ala. to Minn.
formosum	blue	June-July	2–3 ft.	Perennial	Asia Minor
grandiflorum	blue, white	July	2–3 ft.	Perennial	Siberia
var. *album*	white				
var. *albo-pleno*	double white				
var. *flore-pleno*	double blue				
var. *chinense*	double blue				
hybridum	blue, white	June-Aug.	3–4 ft.	Perennial	Asia
var. *Barlowii*	deep blue				
Maackianum	blue, violet	July	3 ft.	Perennial	Siberia
Menziesii	blue	April-June	12–18 in.	Perennial	California
nudicaule	orange-red	April-July	12–18 in.	Perennial	California
Nuttallii	blue	June-July	18–30 in.	Perennial	Columbia River region
Przewalskii	yellow	July-Aug.	2–4 ft.	Perennial	Asia
scopulorum	blue	Aug.-Sept.	2–2½ ft.	Perennial	Western coast
simplex	blue, yellow	June	2 ft.	Perennial	Idaho
tricorne	blue	May	12 in.	Perennial	Northern U. S.
trolliifolium	blue	April	30 in.	Perennial	Columbia River region
Zalil	yellow	June-July	14 in.	Perennial	Persia

NOTES

Mr. R. A. McGinty and Mr. R. W. Webb, Rufus J. Lackland research fellows, were elected to the Society of Sigma Xi and initiated at the annual meeting recently.

The Annual Flower Sermon, provided for in Mr. Shaw's will, was preached at Christ Church Cathedral on May 18 by the Rt. Rev. John A. Richardson, D.D., D.C.L., Bishop of Frederickton, New Brunswick, Canada.

Dr. B. M. Duggar, Physiologist to the Garden, read a paper on "Important Factors in the Constitution of Nutrient Solutions for the Growth of Seed Plants," at the meeting of the St. Louis Academy of Science, May 19.

On May 8, Mr. George H. Pring, Floriculturist to the Garden, spoke before the McKinley High School on "Horticulture as a Profession" and gave an illustrated lecture before the St. Louis Florists' Club on "Plant Curiosities."

For the investigation of the "take-all" and other wheat diseases in the Illinois bottoms near St. Louis, the facilities of the graduate laboratory are being used by Mr. H. H. McKinney and Miss Edith Seymour, of the Office of Cereal Disease Investigations, Bureau of Plant Industry.

Recent visitors to the Garden include the following: Mr. M. C. Jensen, Forest Service, U. S. Department of Agriculture, Madison, Wisconsin; Mr. Naoji Hiratsuka, Director of the Sapporo Branch, Imperial Flax Manufacturing Co.; Dr.

Kwan Koriba, Professor of Plant Physiology, University of Kioto, Japan.

Among the plant pathologists who have recently been in St. Louis to examine the new wheat disease in the vicinity, the following have visited the Garden: G. H. Coons, Michigan Agricultural College; C. D. Learn, Oklahoma Agricultural Experiment Station; J. A. McClintock, Georgia Agricultural Experiment Station; G. L. Peltier, Alabama Agricultural Experiment Station; B. L. Richards, Wisconsin Agricultural Experiment Station; A. D. Selby, Ohio Agricultural Experiment Station; and E. Mead Wilcox, University of Nebraska; also the following representatives of the Bureau of Plant Industry: J. D. Dickson, Raymond Fogelman, R. J. Haskell, J. F. Holmes, A. G. Johnson, C. E. Leighty, and George M. Reed.

STATISTICAL INFORMATION FOR APRIL, 1919

GARDEN ATTENDANCE:

Total number of visitors	4,891

PLANT ACCESSIONS:

Total number of packets of seeds received in exchange	11
Total number of plants received in exchange	353
Total number of plants and seeds received as gifts	38

PLANT DISTRIBUTION:

Total number of plants distributed in exchange	4

LIBRARY ACCESSIONS:

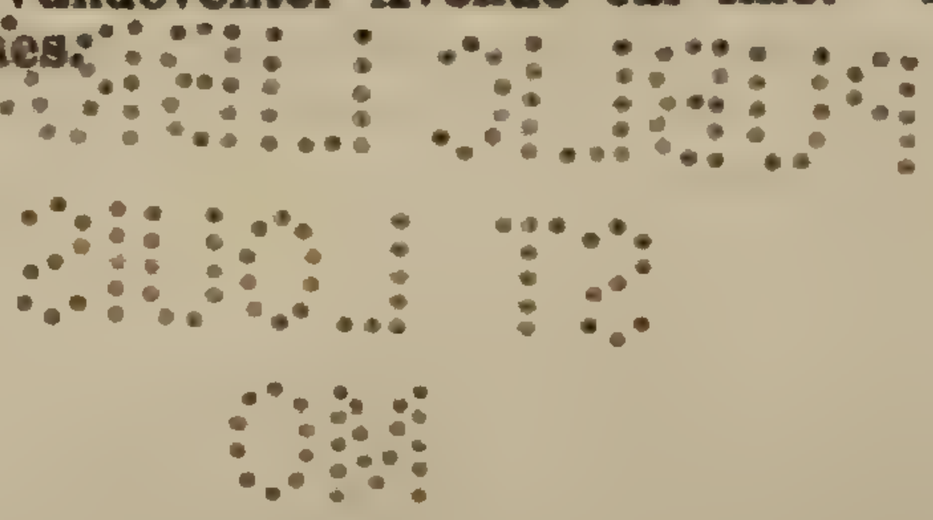
Total number of books and pamphlets bought	10
Total number of books and pamphlets donated	147

HERBARIUM ACCESSIONS:

By Purchase —	
Canton Christian College—Plants of China	118
F. S. Collins—Algae from various localities	100
Rev. John Davis—Plants, mainly from North America	215
Paul C. Standley—Plants of Mexico, collected by Brother G. Arsene	3,250
By Gift —	
Hon. J. R. Churchill—Plants, chiefly from North America	768
J. A. Drushel—Plants of North America	8
Prof. H. M. Fitzpatrick—Fungi from German tunnels and dugouts in France	3
Miss Fanny M. Goetz—*Escholtzia* sp. from California	1
O. S. Ledman—Plants of Missouri	2
C. G. Lloyd—*Cyphella fulvo-disca* Cke. & Mass. from Philippine Islands	1
T. Petch—Corticiums parasitic on tea, coffee, and potato plants	5
G. H. Pring—*Arenga saccharifera* Labill., cultivated at Mo. Bot. Garden	1
Arthur S. Rhoads—Stereums on *Eucalyptus globulus*	2
Dr. H. von Schrenk—Plants of Texas	76
Dr. J. R. Weir—*Poria* species of western United States	240
Dr. J. R. Weir—*Polyporus umbellatus* Fr. from California	1
Dr. S. M. Zeller—*Trametes Stephensii* and *Poria mucida* from vicinity of St. Louis	2
By Exchange —	
College de Longueuil, by Fr. Marie-Victorin—Plants of Canada	266
United States National Museum—Miscellaneous duplicates, chiefly of North American plants	335
University of Wisconsin, by Dr. C. C. Davis—Fungi Wisconsinensis exsiccati, Nos. 51–70 inclusive	20
TOTAL	5,414

The Garden is open to the public every day in the year, except New Year's, Fourth of July, Labor Day, and Christmas—week days from 8:00 A. M. until one-half hour after sunset; Sundays from December to April, 1:00 P. M. until sunset, from April to December, 2:00 P. M. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Boulevard, on the Vandeventer Avenue car line. Transfer south from all intersecting lines.



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MISSOURI BOTANICAL GARDEN BULLETIN

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ONE OF THE ALCOVES CONTAINING AQUARIA.

Missouri Botanical Garden Bulletin

Vol. VII St. Louis, Mo., June, 1919 No. 6

AQUARIUM EXHIBIT

Through the instrumentality of the St. Louis Aquarium Society, the Garden is fortunate in being able to establish a display of fancy fish, exhibited in specially prepared aquaria which have been installed in the alcoves of the aroid house. The attractive rockwork around the aquaria eliminates the artificiality generally associated with such displays. An additional feature of the exhibit is the use of various aquatic plants suitable for aquaria. Such plants are indispensable for maintaining the life of the fish, possessing the power of generating oxygen. Pure oxygen is essential for fish, while carbon dioxide is a plant necessity; thus a balance is maintained, the oxygen given off by the plants being utilized by the fish, while the carbon dioxide exhaled by the fish is absorbed by the plants. Without this reciprocal relation it is impossible to attempt fish culture successfully. It has been repeatedly demonstrated by specialists that aquaria containing sufficient plant life may be tightly covered, the plants giving off enough oxygen to support a proportionate number of fish. The feces excreted by the fish are absorbed by the plant roots as food.

The ornamental value of plants in aquaria is another important feature. The plants used may be either native or tropical, placing stress upon those which possess to the largest degree oxygen-generating properties. The best plants for this purpose are: pond-weed (*Potamogeton crispus*), fish-grass (*Cabomba caroliniana*), eel-grass (*Vallisneria spiralis*), water-weed (*Elodea canadensis*), and ribbon arrowhead (*Sagittaria subulata*).

Pond-weed (Potamogeton crispus).—A native of Europe, forming greenish brown growths. The leaves are lanceolate with undulated margins and the flowers white. One of the best oxygen generators, but an exceedingly noxious weed in outside ponds.

Fish-grass (Cabomba caroliniana).—A native of North America. The green leaves are produced in fan-shaped formation from the central stem which reaches a length of four

feet. The plant is quite attractive, but is a rather poor oxygen generator.

Eel-grass (*Vallisneria spiralis*).—A grass-like plant native of North America, with strap-shaped leaves varying from one to three feet in length, light green in color, and translucent. The star-shaped, floating pistillate flowers are connected to the base of the plant by a long filament which later becomes spiral, submerging the flower for fertilization. The staminate flowers are globular, produced at the base of the plant, from which they break away, rising to the surface of the water. They float with the stream, pollen exposed, so that when contact occurs with the pistillate flowers, pollination readily takes place. This plant is a very good oxygen generator.

Water-weed (*Elodea canadensis var. gigantea*).—Native of North America, moss-like in growth. The leaves are in whorls upon light green stems which form strands reaching several feet in length. This is an excellent oxygen generator, growing completely submerged. It may become a pestiferous weed in lily ponds.

Ribbon arrowhead (*Sagittaria subulata*).—Native of North America. The submerged leaves are equitant, strap-shaped, dark green, one foot in length. The growth above water bears lance or sagittate leaves. This plant is one of the most valuable for aquarium purposes, multiplying rapidly by stoloniferous growths and supplying a plentiful amount of oxygen. A very noxious weed in ponds.

PLANTS SUITABLE FOR AQUARIA

Botanical name	Common name	Habit	Habitat
Aponogeton distachyus	Cape pond-weed	Floating	South Africa
Aponogeton fenestralis	Lace-leaf	Submerged	Madagascar
Azolla caroliniana	Water moss	Floating	North America
Cabomba caroliniana	Fish-grass	Submerged	North America
Callitriche verna	Spring starwort	Submerged or floating	North America
Ceratopteris thalictroides	Water fern	Leaves floating or above water	Tropics
Cryptoooryne Griffithii	Mosaic leaf	Submerged	Malaya
Cyperus alternifolius var. *variegatus*	Variegated umbrella plant	Leaves above water	Madagascar
Cyperus Papyrus	Egyptian pepper plant	Leaves above water	Egypt
Eichhornia speciosa	Water hyacinth	Floating	Southern United States
Elodea (*Anacharis*) *canadensis*	Water-weed	Submerged	North America
Eriocaulon septangulare	Hair grass	Submerged or above water	Southern United States

Botanical name	Common name	Habit	Habitat
Fontinalis antipyretica	Willow moss	Submerged or above water	North America
Heteranthera limosa	Bog herb	Floating	North America
Hippuris vulgaris	Mare's tail	Submerged or above water	North America
Isoetes Engelmanni	Quillwort	Submerged	North America
Jussiaea longifolia	Primrose willow	Floating	Brazil
Lemna minor	Duck weed	Floating	North America
Limnobium Spongia	American frogbit	Floating	North America
Limnocharis Humboldtii	Water poppy	Floating	South America
Ludwigia Mulerttii	Water purslane	Floating	Amazon River
Myriophyllum proserpinacoides	Parrot's feather	Floating	Tropics
Nuphar sagittaefolium	Spatter-dock	Submerged or above water	North America
Pistia Stratiotes	Water lettuce	Floating	Tropics
Salvinia natans	Floating gem	Floating	Tropics
Potamogeton crispus	Pond-weed	Submerged	Europe
Sagittaria subulata	Ribbon arrowhead	Submerged or above water	North America
Trapa natans	Water chestnut	Floating	China
Utricularia vulgaris var. *americana*	Bladderwort	Submerged	North America
Vallisneria spiralis	Eel-grass	Submerged	North America

FISH TO BE FOUND IN AQUARIA

Among the curious fish from foreign lands will be seen the *Mollinesia latipinna*, or sail fish, with its huge, brilliantly colored dorsal fin which it expands like a sail when courting. These fish are natives of the bayous and small streams of the Gulf and particularly of Louisiana and Mexico.

The Mexican sword-tailed fish will be found in another tank, where it is readily distinguished by its long sabre-like tail. The colors of this fish baffle description.

The South American peacock-fish, one of the smallest known fish, while called the "millionfish" in its native waters on account of its vast numbers, is shown here in a small family, as, like the two above-named fishes, it is tropical in nature and requires much heat during the winter. It shows all colors of the rainbow and is covered with dots exactly like the eyes of the peacock's tail.

Another rare South American fish, the danio or zebra fish, resembling a miniature striped bass, will be found in several forms. It is incessantly active and scarcely ever stops for breath, taking its food in quick, snappy darts.

The paradise fish is another interesting variety, one of the earliest known aquarium fish. Its brothers, the fighting fish of Siam (*Betta pugnax* and *Betta rubra*), will be found near it. These latter fish are used for fighting by the Sia-

mese, great fortunes and estates or women changing hands on the results of these singular battles. These fish are desperately pugnacious and will fight until one or the other is literally torn to pieces. The negro fish, the stilt fish, the ruby fish, and the albino fish will also be found in this collection. In another alcove will be found the sacred blue carp of Japan and the sacred red carp of the same country.

The East Indian and Japanese shubunkin, or brocaded goldfish, will be found in an alcove where are displayed Japanese lion-headed goldfish, Korean eggfish, Chinese moor (black) dragon-eyed goldfish, and the more beautiful forms of goldfish, such as butterfly-tails, lace-tails, fan-tails, and comet-tails, scaled and unscaled, in colors from gold to blue and mottled calicoes.

Among the wild native fish will be seen the rainbow darters, the sculpin or toad-fish, the various minnows and horn-pout, the red and common sunfish, the purple minnow, the rainbow dace, the striped dace, the common shiner, and the darters or top-water minnows with their wonderful checkerboard colors.

AQUARIUM MANAGEMENT

The chief sources of failure in the management of aquaria are overcrowding, overfeeding, sudden temperature changes, lack of proper plant life, and insufficient lighting.

The tendency to overcrowd aquaria is a common fault. A safe rule to follow is to allow one gallon of water to every one-inch fish; thus a ten-gallon aquarium may contain ten one-inch fish or two five-inch fish. When the fish continually come to the top and gasp for air it is a sign either of overcrowding or of the presence of some decomposed matter in the water.

Overfeeding of fish is an evil usually due to ignorance. Under natural conditions, in order to procure food, fish have to exert themselves, but as such exercise is not possible in a confined aquarium, food must be given in smaller amounts. No more should be given than can be consumed at once, and if any remains after five minutes it should be removed with a dip tube. When the temperature of the water is 60° F. or higher, daily feeding is permissible, but as the temperature goes down feeding should be reduced to two- or three-day intervals.

If change of water becomes necessary, sudden fluctuation of temperature should be avoided, as it is quite often the primary cause of disease. Every few days a tenth of the volume of water may be changed slowly. A sprinkling pot

is desirable for adding water, the small streams becoming well aërated.

An evidence of sickness in fish is the dragging of the back fin which normally is carried upright. The movements also become sluggish and a tendency to hide in a dark corner is noticed. The body becomes thin, the fins split and are streaked with red, and the excrement shows a pale color. Sick fish should be removed quickly from the aquarium, and if the disease affecting it be contagious, the tank should be disinfected by adding three grains of potassium permanganate to a gallon of water, having previously removed the fish and the snails.

The mineral constituents of the water are absorbed by the fish and plants to such an extent as to necessitate addition of these materials at intervals. A mixture of three parts of evaporated sea salt to one part of Epsom salts added at the rate of one teaspoonful to twenty gallons of water every two weeks will prove beneficial. Acid conditions resulting in the crumbling of the shells of snails may be eliminated by keeping a piece of plaster of Paris or gypsum in the aquarium. In dissolving, it neutralizes the acid, but as it only dissolves under acid conditions there is no danger of the water becoming too alkaline.

In order to get rid of a good deal of decomposing matter in the aquarium, Japanese, African, and European red snails, as well as water mussels and weather-fish, are extremely useful and should find place in every tank. The mussels are necessary for keeping down algal growth.

Planting is done directly in sand which is spread to a thickness of one inch. Two inches of water is then added, the roots spread out, and another one-inch layer of sand and pebbles placed on top. The aquarium should be allowed to stand at least a day before the fish are added.

A globe is one of the worst possible containers for fish. When filled the air surface is small in proportion to the water bulk; the convex surface of the globe acts as a lens, focusing light into the eyes of the fish; proper plant growth is difficult, and in addition overcrowding and overfeeding are apt to result.

THE LINNEAN HOUSE

The Linnean House, which was erected by Mr. Shaw in 1882 to house the palm collection and part of the floral displays and is the only greenhouse remaining of those built by him, has been radically remodelled and presents a novel

effect. To admit more light the old-fashioned, half-slate, half-glass roof has been replaced by a modern all-glass roof. Within the house the central feature is a rocky ledge from which a spring issues, emptying into a circular pool, the entire structure being surmounted by the overgrown rock and stump of a tree described in the April, 1919, number of the BULLETIN. *Lycopodium lucidulum* is growing in the cracks and crevices of the ledge. The banks on either side of the walk are planted with various conifers and ericaceous plants, the latter to produce effective masses of color at certain times of the year. The brick walls will eventually be covered with various species of ivy (Hedera), while the entrances will be arched by the foliage and brilliant orange flowers of the false holly (*Chorizema ilicifolium*).

Among the plants represented in this house are:

Andromeda calyculata
Andromeda floribunda
Andromeda japonica
Andromeda speciosa
Azalea amoena
Azalea Hinodigiri
Azalea indica var.
Azalea Kaempferi
Azalea ledifolia alba
Azalea yodogawa
Camellia japonica var.
Daphne Cneorum
Erica alba minor
Erica Alporti
Erica coccinea
Erica cuprea
Erica × Edward VII.
Erica Hammondi
Erica hypnoides
Erica melanthera
Erica monstrosa
Erica pilosa
Erica Serliei
Erica sericea
Erica stricta
Erica tenella
Erica Tetralix
Erica vagans
Erica vulgaris tomentosa
Erica vulgaris variegata
Kalmia latifolia (mountain laurel)
Lagerstroemia indica (crape myrtle)
Rhododendron hybrids

CONIFERS

Abies arizonica
Abies balsamea
Abies balsamea argentea
Abies concolor
Abies concolor lasiocarpa
Abies fraxoniana
Abies homolepis umbellata
Abies magnifica glauca
Abies nobilis glauca
Abies Nordmanniana
Abies pectinata
Abies pectinata pendula
Abies pectinata pyramidalis
Abies Pinsapo glauca
Abies sachalinensis
Abies sachalinensis nemoralis
Abies sibirica
Abies subalpina
Abies umbiculata
Abies Veitchii
Abies Veitchii olivacea
Abies "823 Purdom"
Araucaria imbricata
Cedrus atlantica
Cedrus Deodara
Cedrus Libani
Cephalotaxus drupacea
Chamaecyparis nutkaensis
Cryptomeria japonica aurea
Cupressus Lawsoniana
Cupressus Lawsoniana minima glauca
Cupressus Lawsoniana pyramidalis glauca
Cupressus Lawsoniana "Triomph von Boskoop"

VIEW IN LINNEAN HOUSE.

SPRING IN LINNEAN HOUSE.

Juniperus canadensis
Juniperus canadensis aurea
Juniperus chinensis mascula
Juniperus chinensis pendula
Juniperus chinensis Pfitzeriana
Juniperus chinensis procumbens
Juniperus chinensis Sargentii
Juniperus communis aurea
Juniperus communis hibernica
Juniperus conferta
Juniperus japonica
Juniperus japonica nana aureo variegata
Juniperus macrocarpa
Juniperus nana canadensis
Juniperus Pinchoti
Juniperus recurva squamata
Juniperus Sabina
Juniperus Sabina prostrata
Juniperus Sabina tamariscifolia
Juniperus stricta
Juniperus sphaerica
Juniperus virginiana
Juniperus virginiana Cannartii
Juniperus virginiana elegantissima
Juniperus virginiana glauca
Juniperus virginiana globosa
Juniperus virginiana pendula
Juniperus virginiana Schottii
Larix europaea
Libocedrus decurrens
Picea alba
Picea Alcockiana
Picea Balfouriana
Picea canadensis
Picea coerulescens
Picea excelsa
Picea excelsa Gregoryana
Picea excelsa inversa
Picea excelsa Ohlenderffii
Picea Kayamai
Picea Meyeri
Picea nigra
Picea orientalis
Picea orientalis gracilis
Picea pungens
Picea pungens Kosteri
Picea "455 Schneider"
Pinus densiflora
Pinus Laricio austriaca
Pinus montana
Pinus Strobus
Pinus suchuensis
Pinus sylvestris
Pinus "8815 Wilson"
Pseudolarix Kaempferi
Pseudotsuga Douglassii
Retinispora leptoclada
Retinispora obtusa
Retinispora obtusa aurea Cripssi
Retinispora obtusa filicoides
Retinispora obtusa lycopodiodes
Retinispora obtusa nana
Retinispora obtusa nana aurea
Retinispora obtusa pygmea
Retinispora pisifera
Retinispora pisifera filifera
Retinispora pisifera plumosa
Retinispora pisifera squarrosa Veitchii
Sciadopitys verticillata
Sequoia gigantea
Taxus baccata
Taxus baccata fastigiata
Taxus baccata aureo-marginata
Taxus baccata repandens
Taxus cuspidata
Taxus cuspidata nana
Taxus cuspidata brevifolia
Thuya gigantea
Thuya occidentalis
Thuya occidentalis Douglassii aurea
Thuya occidentalis Ellwangeriana
Thuya occidentalis globosa
Thuya occidentalis Hoveyi
Thuya occidentalis lutea
Thuya occidentalis pyramidalis
Thuya occidentalis Rosenthalli
Thuya occidentalis spiralis
Thuya occidentalis Wareana
Thuya occidentalis Woodwardii
Thuya occidentalis Standishi
Thuya "7244 Wilson"
Thuya "7629 Wilson"
Thujopsis dolobrata
Tsuga canadensis
Tsuga canadensis Sargentii pendula
Tsuga Mertensiana

NOTES

At the commencement of Washington University, June 12, degrees were conferred on members of the graduate laboratory as follows: Doctor of Philosophy, Henry Schmitz; Master of Arts, Adele L. Grant, R. A. McGinty, Alexander Lurie, and R. W. Webb.

Dr. George T. Moore, Director of the Garden, lectured before the Artists' Guild, May 3, on "Plants and People."

Dr. Norma E. Pfeiffer, of the University of North Dakota, has resumed at the Garden her monographic study of the genus Isoetes.

On the evening of June 5, before the cereal pathologists, Dr. B. M. Duggar, Physiologist to the Garden, presented the first paper on the subject, "Disease Resistance in Plants: Immunity."

Dr. B. M. Duggar, Physiologist to the Garden, spoke before the members' conference of the Chamber of Commerce, June 11, on "Why an Art-in-Industry Exhibition in St. Louis is Indispensable."

Mr. G. H. Pring, Floriculturist to the Garden, published an article in the June issue of the Gardeners' Chronicle of America on "Orchids of the Missouri Botanical Garden" and also contributed a paper to the May issue of Aquatic Life on "Aquatic Plants and Their Cultivation."

The first session of the St. Louis Conference of Cereal Pathologists was held in the graduate lecture room, June 5, following a buffet luncheon served by the Garden. Dr. George T. Moore, Director of the Garden, outlined the history and work of the Garden. The luncheon was preceded by a brief discussion in the graduate laboratory—led by Dr. Duggar and assisted by all graduates—of the investigations in progress by members of the staff, research fellows, and other investigators.

Recent visitors to the Garden include Dr. P. J. O'Gara, director department of agricultural and smelter by-product investigations, American Smelting and Refining Co., Salt Lake City, June 11; Mr. Edgar M. Ledyard, director agricultural department, United States Smelting, Refining and Mining Co., Salt Lake City; Prof. Kingo Miyabe, of the Hokkaido Imperial University, Sapporo, Japan, June 18-19; Baron Henry d'Anchald, member of the Academy of Agriculture of France, June 24.

Volume VI, Number 2, of the Annals of the Missouri Botanical Garden has been issued recently with the following contents:

"Studies in the Physiology of the Fungi. VI. The Relation of Bacteria to Cellulose Fermentation Induced by Fungi, with Special Reference to the Decay of Wood." Henry Schmitz.

"Studies in the Physiology of the Fungi. VII. Growth of Wood-Destroying Fungi on Liquid Media." S. M. Zeller, Henry Schmitz, and B. M. Duggar.

"Merulius in North America, Supplementary Notes." E. A. Burt.

"Seed Disinfection for Pure Culture Work." H. C. Young.

"Seed Disinfection for Pure Culture Work: The Use of Hypochlorites." B. M. Duggar and Anne W. Davis.

STATISTICAL INFORMATION FOR MAY, 1919

GARDEN ATTENDANCE:

Total number of visitors	15,100

PLANT ACCESSIONS:

Total number of packets of seeds received in exchange	6
Total number of plants received in exchange	9
Total number of plants and seeds received as gifts	97

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought	5
Total number of books and pamphlets donated	159

HERBARIUM ACCESSIONS:

By Purchase —

Miss Edith I. Watt—Private herbarium of the late D. A. Watt, consisting primarily of ferns and fern allies, estimated at	10,700

By Gift —

Dr. H. W. Anderson—*Peniophora quercina*	1
Joseph R. Bohr—Undetermined plant from Michigan	1
Dr. W. A. Murrill—*Septobasidium cirratum* Burt from Bahamas	1
Dr. L. O. Overholts—Fungi from New Hampshire and Pennsylvania	23
S. B. Parish—Plants of California	87
Dr. H. von Schrenk—Fungi on railway ties from Norfolk, Virginia	2
Dr. J. R. Weir—Fungi from Cuba	2
Dr. F. A. Wolf—*Protocaranospora nigricans* Atk. & Edg.	1

By Exchange —

J. A. Drushel—Plants of the United States	10
Caroline C. Haynes—Hepaticae from eastern United States	29
Ralph Hoffmann—Plants of Massachusetts, Wisconsin, and Missouri	1,002
New York Botanical Garden—Plants of Colombia, collected by H. H. Rusby and F. W. Pennell	170
TOTAL	12,029

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Engineer.

P. FOERSTER,
Farm and Stables

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MISSOURI BOTANICAL GARDEN BULLETIN

Vol. VII SEPTEMBER, 1919 No. 7.

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ST. LOUIS, MO.
1919

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Missouri Botanical Garden Bulletin

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VIEWS OF GARDEN

HENRY SHAW
Reproduction of painting by Richard Miller

VIEW OF MAIN ENTRANCE FROM EXTERIOR, ERECTED 1858

VIEW OF MAIN ENTRANCE FROM INTERIOR

Looking south across knolls to mausoleum

Looking north across rose garden to Linnean House

TWO VIEWS OF GARDEN TAKEN FROM SAME SPOT

TROPICAL LILY POOLS AND MAIN CONSERVATORY. ERECTED 1912-13

ROSE GARDEN LOOKING TOWARD LINNEAN HOUSE

ROSE GARDEN WITH MAIN CONSERVATORY IN BACKGROUND

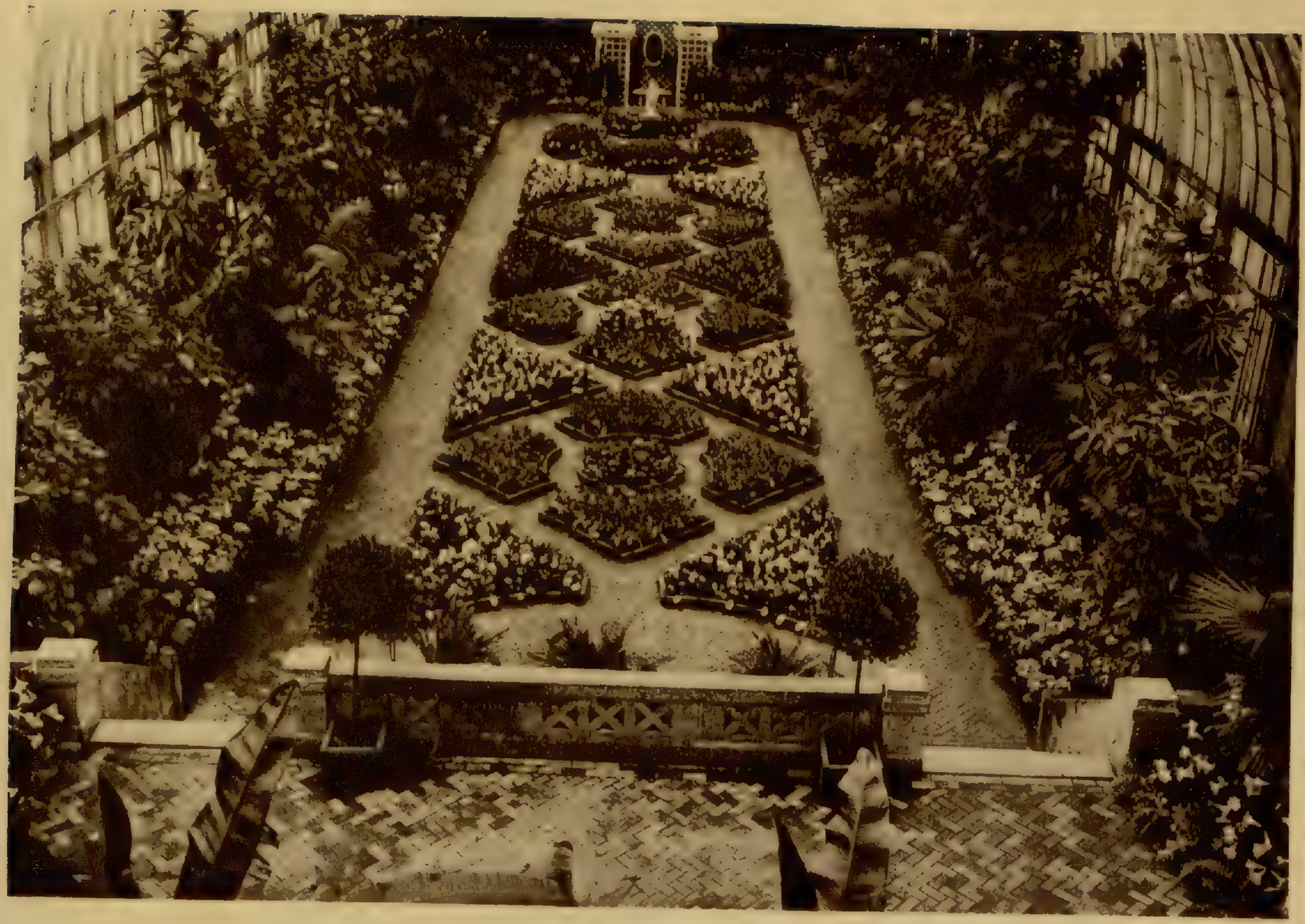
CORNER OF PERENNIAL GARDEN—GAZING GLOBE AND MAGNOLIA TREE IN FOREGROUND

PERENNIAL GARDEN SHOWING LOTUS POOLS

INTERIOR OF LINNEAN HOUSE. ERECTED BY HENRY SHAW IN 1833

FRUITING BANANA TREE IN FLORAL DISPLAY HOUSE

CHRYSANTHEMUM SHOW IN FLORAL DISPLAY HOUSE



BULB SHOW IN FLORAL DISPLAY HOUSE

TRELLISED GARDEN ILLUSTRATIVE OF SHAKESPEARE'S TIME. SHOWN IN FLORAL DISPLAY HOUSE DURING SHAKESPEAREAN TRICENTENARY

ROCKERY IN AROID HOUSE

AROID HOUSE. ONE OF THE ALCOVES CONTAINING AQUARIA

BROMELIAD HOUSE SHOWING VANILLA PLANT ON TRELLIS IN REAR

GOOSE OR PELICAN PLANT IN BROMELIAD HOUSE

ONE OF THE ORCHID-GROWING HOUSES

DOVE ORCHID (PERISTERIA ELATA)

MAIDENHAIR TREE (GINKGO BILOBA). NATIVE OF CHINA

EXTERIOR OF PALM HOUSE

INTERIOR OF PALM HOUSE

INTERIOR OF FERN HOUSE

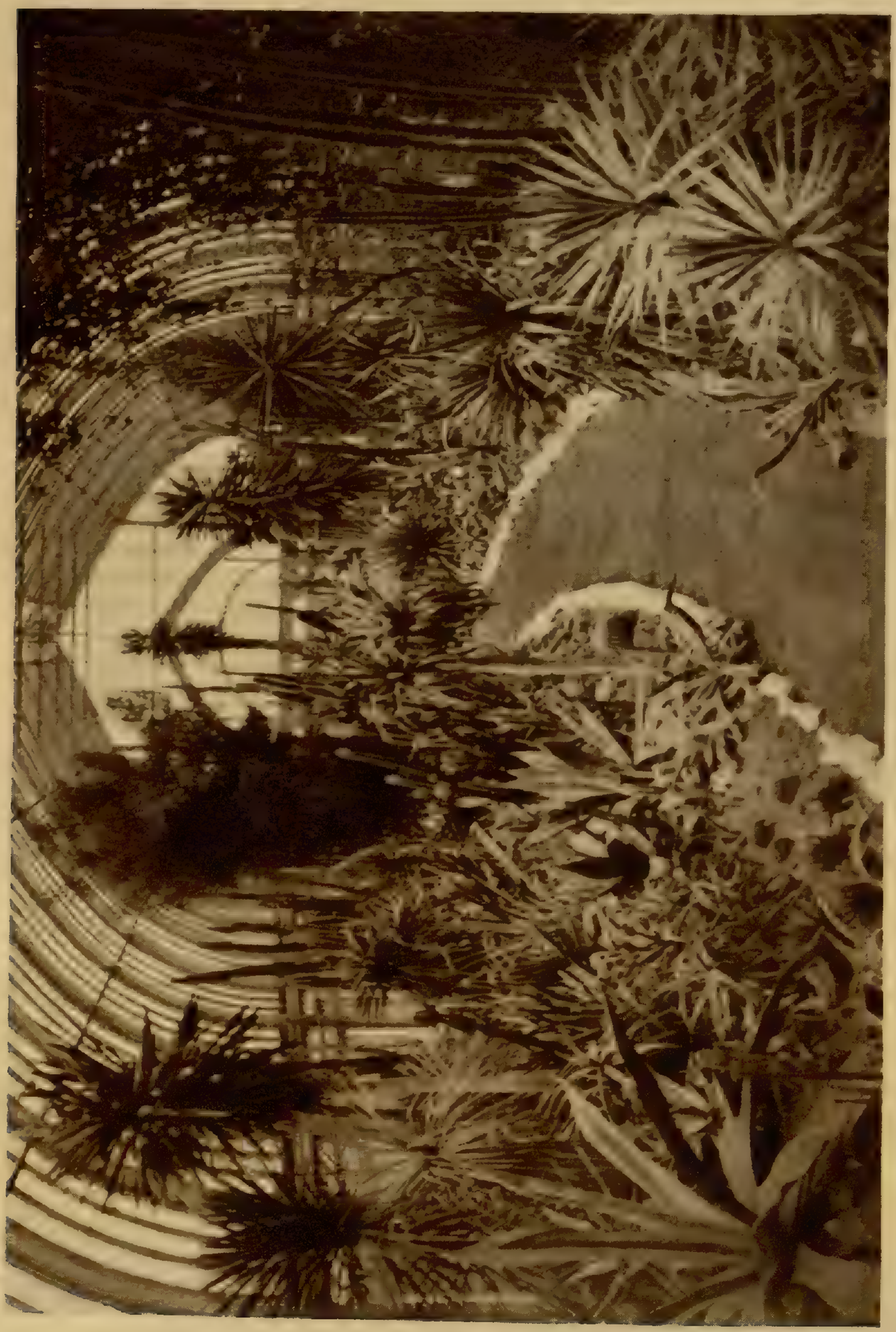
BRIDGE AND GROTTO IN FERN HOUSE

INTERIOR OF CYCAD HOUSE

CENTRAL PANEL OF ITALIAN GARDEN SHOWING PERGOLA

ITALIAN GARDEN LOOKING TOWARD CONSERVATORIES

STATUE OF JUNO IN CENTER OF ITALIAN GARDEN. PURCHASED BY HENRY SHAW IN 1886. (COPY OF AN ANTIQUE NOW IN NATIONAL MUSEUM, NAPLES)



INTERIOR OF SUCCULENT HOUSE

INTERIOR OF ECONOMIC HOUSE SHOWING FRUITING PAPAYA IN BACKGROUND

ECONOMIC HOUSE. COFFEE TREE IN BLOOM

CENTRAL PATH THROUGH ECONOMIC GARDEN

COLLECTION OF ORNAMENTAL GRASSES IN ECONOMIC GARDEN

VISTA FROM GROVE ACROSS KNOLLS TO THE LINNEAN HOUSE

POOLS FOR HARDY WATER-LILIES. KNOLLS IN BACKGROUND

MAIN CONSERVATORIES FROM KNOLLS

CLEVELAND AVENUE GATE-HOUSE, MUSEUM AND SHELTER CONTAINING STATUE OF VICTORY

CLEVELAND AVENUE GATE-HOUSE AND MONUMENT TO AMERICAN SCIENCE

MAUSOLEUM OF HENRY SHAW

TOMB OF HENRY SHAW

FORMER COUNTRY RESIDENCE OF MR. SHAW, ERECTED 1849. NOW OCCUPIED BY SCHOOL FOR GARDENING

GREENHOUSES USED EXCLUSIVELY FOR EXPERIMENTAL WORK BY GRADUATE STUDENTS IN THE HENRY SHAW SCHOOL OF BOTANY

PERGOLA AND TEST GARDEN, THE LATTER DEVOTED TO TESTING NEW OR RARE VARIETIES OF SEEDS AND PLANTS

ADMINISTRATION BUILDING

Containing offices, library, herbarium, and laboratories. The right-hand half of this building was Mr. Shaw's city residence, originally situated on Seventh and Locust Streets, moved to its present site in 1890 in accordance with a provision of his will.

CORNER OF LIBRARY READING-ROOM. FORMERLY DRAWING ROOM OF MR. SHAW'S CITY RESIDENCE

VIEW OF HERBARIUM SHOWING HOW DRIED SPECIMENS ARE STORED

CONFERENCE AND STUDY ROOM FOR RESEARCH STUDENTS IN HENRY SHAW SCHOOL OF BOTANY

GRADUATE LABORATORIES IN HENRY SHAW SCHOOL OF BOTANY

VIEWS OF DIRECTOR'S RESIDENCE

VIEW ACROSS NORTH AMERICAN TRACT FROM DIRECTOR'S RESIDENCE

LAKE IN NORTH AMERICAN TRACT

WINTER SCENE IN GARDEN

CENTRAL HEATING PLANT FROM WHICH ALL BUILDINGS IN GARDEN ARE HEATED WITH EXCEPTION OF RESIDENCES

RESIDENCE OF CHIEF ENGINEER

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MISSOURI BOTANICAL GARDEN BULLETIN

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ORCHIDS PRESENTED TO QUEEN OF BELGIUM.

Missouri Botanical Garden Bulletin

Vol. VII St. Louis, Mo., October, 1919 No. 8

A VARIETY NUT ORCHARD

A development of greatest importance to the nut industry of the United States is the planting this fall of a variety nut orchard at the Missouri Botanical Garden. It is the first attempt in the history of American agriculture to collect in one place and systematically test all varieties of native and imported nuts which are hardy in the latitude of St. Louis.

It is particularly appropriate that the Garden be the institution to undertake this work, because of the fact that there is the greatest collection of wild nuts on the American continent within a radius of 200 miles of St. Louis. The lands adjacent to the Mississippi River and its tributaries contain tens of thousands of pecans, hickories, and black walnuts. Already from this wonderful collection there have been found a number of varieties of nuts that are of great merit, and it only remains for the virtues of these to become sufficiently well known to lay the foundations of a prosperous and enduring industry in Missouri, Kentucky, southern Indiana, Illinois, and such other parts of the country as have similar climatic conditions.

In the following list are given the sorts that the initial planting will contain, and later such new varieties of promise and merit as are discovered will be added to the orchard. The trees will be brought to bearing and complete records will be kept of their performances. In addition to this, there will be placed at the Garden a collection of nuts that are grown there and elsewhere, thus making the institution a clearing-house of information, which will be of the highest value to present and future growers of nut trees.

While this work was initiated by the Missouri Botanical Garden, much of its success will depend upon the coöperation of others interested in establishing a nut industry in this part of the country. Mr. S. M. McMurran, in charge of Nut Disease Investigation for the U. S. Department of Agriculture; Mr. J. Jones, nurseryman, of Lancaster, Pa.; Mr.

J. F. Wilkinson, nurseryman, of Rockport, Ill.; Mr. Willard G. Bixby, secretary of the Northern Nut Growers' Association, and others prominently identified with the development of this industry have thus far indicated their willingness to be of all possible assistance.

LIST OF NUT TREES IN INITIAL PLANTING

PECANS

Variety Butterick. Grayville, Ill. Parent tree still standing; bearing record prolific. Character of nut: thin-shelled, excellent cracking quality, kernel plump and of good quality.

Variety Kentucky. Rockport, Ind. Parent tree still standing; bearing record prolific. Character of nut: thin-shelled, kernel plump and of good quality.

Variety Major. Henderson County, Ky. Parent tree still standing; bearing record prolific. Character of nut: thin-shelled, cracking quality good, kernel plump and of good quality.

Variety Greenriver. Henderson County, Ky. Parent tree still standing; bearing record prolific. Character of nut: cracking quality good, kernel plump and of good quality.

Variety Niblack. Vincennes, Ind. Parent tree still standing; bearing record prolific. Character of nut: thin-shelled, excellent cracking quality.

Variety Posey. Gibson County, Ind. Parent tree not standing; bearing record regular, but not prolific. Character of nut: thin-shelled, excellent cracking quality.

Variety Indiana. Knox County, Ind. Parent tree still standing; bearing record excellent. Character of nut: shell medium, cracking quality good, kernel plump and of good quality.

Variety Busseron. Knox County, Ind. Parent tree still standing; bearing record prolific. Character of nut: shell medium, of good cracking quality, kernel plump and of good quality.

BLACK WALNUTS

Variety Stabler. Howard County, Md. Parent tree very large, still standing; has borne sixteen bushels in one crop. Character of nut: thin-shelled, of excellent cracking quality, with full kernel.

Variety Thomas. King of Prussia, Pa. Parent tree, originated by Joseph W. Thomas, not now standing; bearing

record very productive and satisfactory. Character of nut: medium shell, best cracking quality of all large walnuts, kernel large and full.

Variety Ohio. McCutchenville, Ohio. Parent tree still standing; bearing record good. Character of nut: medium to large, thin-shelled, of excellent cracking quality, kernel of good quality.

Variety Miller. Parent tree bearing record prolific. Character of nut: large, medium shell, of good cracking quality.

Variety Lancaster. Fruitville, Pa. Parent tree still standing; has been very heavy bearer. Character of nut: medium to large, heart-shaped, medium shell, of best cracking quality, kernel very full and good.

PERSIAN WALNUTS

Variety Wiltz Mayette. R. Wiltz, San Jose, Cal. (seedling of Mayette). Parent tree still standing; of good bearing record (best variety of Mayette type). Character of nut: very large, thin-shelled, of best cracking quality, kernel full and rich.

Variety Vrooman Franquette. Vrooman Orchard, Santa Rosa, Cal. (seedling of Franquette). Parent tree still standing; one of best bearing and hardiest walnuts east. Character of nut: large, pointed, shell thin and soft, of excellent cracking quality, kernel very plump and white.

Variety Rush. J. G. Rush, Lancaster County, Pa. Parent tree still standing; excellent bearing record. Character of nut: medium to large, shell thin and soft, of excellent cracking quality, kernel full and of good quality.

Variety Alpine Mammoth. France, Alps Mountains (propagated from very select, heavy-bearing seedling tree, Burlington, N. J.). Parent tree not standing; bearing record good. Character of nut: large, shell very thin and soft, of best cracking quality, kernel full.

HICKORIES

Variety Kirtland (shagbark). Yalesville, Conn., by H. S. Kirtland. Parent tree still standing; of excellent bearing record, one of the finest shagbarks. Character of nut: large, shell smooth and of good appearance, of excellent cracking quality, kernel full and very good.

Variety Stanley (shellbark). Carthage, Ind., by Thos. T. Newby. Parent tree not standing; bearing record excellent;

a beautiful tree with luxuriant foliage. Character of nut: very large, shell thin for this species, excellent cracking quality, full kernel.

Variety Pleas Hybrid (pecan and bitternut). Collinsville, Okla. Parent tree standing; very heavy bearer. Character of nut: large, shape of pecan but somewhat flattened, excellent cracking quality, kernel of good quality when fresh.

Variety Beaver Hybrid (bitternut and shagbark). Millerstown, Pa. Parent tree still standing; good bearing record, very beautiful and rapid-growing. Character of nut: large, shell smooth, white, and of good appearance, good cracking quality, kernel full and of good quality but becomes rancid sooner than pure shagbarks.

PERFUME PLANTS

The use of plants and flowers for perfumery dates from antiquity. History first records the use of perfumery for religious ceremonies in the form of incense. This consisted mainly of aromatic woods and barks, fragrant balms, and resins, referred to in the scriptures as frankincense and myrrh and the sandal and aloes wood of later date.

Perfume was essential in all religious ceremonies in Egypt, being offered in the form of ointment and incense. No king could be crowned without being anointed by the priests, and on special occasions incense was offered up in acknowledgment of the monarch's supreme exaltation. That ancient Egyptians were skilled in the art of perfumery making is attested by a specimen of ointment 3,000 years old in a perfect state of preservation at Alnwick Castle Museum, England.

The Greeks and Romans employed perfumery to a great extent, the Greeks in the time of their splendor making certain essences similar to modern times. Athenaeus quotes a writer of a treatise on perfumes as saying: "The iris is best in Elis and Cyzicus; the perfume made from roses is most excellent at Phaselis, and that made at Naples and Capua is also very fine. That made from crocus (saffron) is in the highest perfection at Soli in Cilicia, and at Rhodes. The essence of spikenard is best at Tarsus, and the extract of vine leaves is made best at Cyprus and Adramyttium. The best perfume from marjoram and from apples comes from Cos. Egypt bears the palm for its essence of cyperus, and the next best is the Cyprian and Phoenician, and after that comes the Sidonian. The perfume called panathenaicum is made at Athens, and those called metopian and mendesian are pre-

pared with the greatest skill in Egypt.'' There is no reference in this writer's work to suggest a knowledge of distillation, and it was not until the tenth century that the process was discovered by Avicenna, an Arabian doctor. Previous to this period perfumery consisted of resins, spices, oils, or ointments, scented by contact with fragrant substances.

Five hundred years have passed since the people of southern France have learned the secret of extracting the perfume of flowers and preserving it. The largest industry for the manufacture of natural perfumes is located in Grasse, at the factory of Bruno Court, where 115,000 acres are cultivated for the production of flowers. Every year an average of 1,860 tons of orange blossoms, 930 tons of roses, 147 tons of violets, and 127 tons of jasmine, etc., are picked by hand and carried to the factory where they are sorted and the stamens and pistils separated. Since the average weight of a jasmine flower is about 120 milligrams, approximately five billion blossoms are annually picked by hand. It is interesting to note that two-thirds of the flower pickers of Grasse live to the age of seventy.

The principal methods of procuring the aroma from the flowers are maceration, enfleurage, and distillation. The odors of all vegetable matter are contained in a constituent called otto. This essential oil, or otto, is always present in a liquid form varying in color from light straw to dark red or brown and possessing the odor of the substance from which it is derived. As it exists in such small proportion, when isolated, a remarkable concentration of odor is contained. The yield of otto varies according to the material. For example, nutmeg and lemon rind contain six per cent or more and can profitably be extracted by expression. Roses, however, yield a very low percentage, so little that one hundred pounds of petals will furnish but three teaspoonfuls of otto.

The process of distillation is generally known, consisting of vaporizing a liquid in a closed vessel and conducting the vapor to a receiver in which it is condensed by the application of cold water. When the flowers are placed in the still with the correct proportion of water and heat applied the otto, being volatile, rises with the steam, and both being condensed together, readily separate when cool. The water distillate from the flowers is conserved in huge containers to be used again, or sold as distilled water, rose water, jasmine water, etc.

The more delicate flowers, as tuberose. jonquil, and jasmine, impart their fragrance by the cold enfleurage process. The

flowers are placed upon the purest of scentless cold lard, which is spread upon glass plates secured to wooden frames. Fresh blooms are daily added until the lard has become impregnated with the otto, the latter being extracted by agitating in cold alcohol and evaporating.

Another method of extracting perfumes is by hot maceration, the flowers being immersed and continually stirred in heated lard. The perfumed lard is afterwards separated from the flowers by filtration and pressure. The most modern method is by employing volatile solvents, by which, in a closed extraction apparatus, light petroleum spirit dissolves the essences, and after evaporation in a vacuum leaves them in a solid form.

Sweet odors are generally classified under three headings: (1) floral, including all those obtained from sweet-smelling flowers, (2) aromal, those derived from all spices, herbs, and roots, (3) balsamic, obtained from such substances as resins, musks, etc. Various essences in compound are used as substitutes in the manufacture of certain perfumes. The heliotrope in concentrated form suggests the aroma of vanilla combined with that of bitter almonds. With this in mind the perfumer makes an excellent "extract of heliotrope" by combining a tincture of vanilla with a small proportion of otto of bitter almonds and sufficient rose and orange flower essences to give sweetness and floral character. A substitute for magnolia odor is obtained by mixing orange flower, tuberose, and violet essences, the addition of a touch of cedrat giving the peculiar sweetness characteristic of the flower.

Chemical substitutes for perfumes, compounded by the chemist, enter greatly in the present-day market, especially in the cheaper perfumery. The laboratory rival of any natural perfume may be a chemical artificial product which is absolutely identical with it, both physically and chemically. Among the sources of perfumery are the laboratory by-products of coal tar.

The Garden collection of tropical perfume plants is located in the south side of the economic house and includes various species of jasmines, myrtles, winter-sweet, patchouli, orange, lemon, cinnamon, camphor, etc. The hardy flowers used for perfumes, such as tuberose, lavender, violet, etc., are grown in season in the economic garden south of the main conservatories.

PLANTS CHIEFLY USED FOR PERFUMERY.

Common name	Botanical name	Part used
Almond (bitter)	*Amygdalus amara*	Kernel of fruit
Cassie	*Acacia Farnesiana*	Flowers
Cinnamon (true)	*Laurus Cinnamomum*	Bark
Jasmine	*Jasminum odoratissimum*	Flowers
Lavender	*Lavandula vera*	Leaves
Lemon	*Citrus Medica*	Rind of fruit
Orange flower	*Citrus Bigaradia*	Flowers
Orris	*Iris florentina*	Rhizome
Patchouli	*Pogostemon Heyneanus*	Leaves
Rose	*Rosa centifolia*	Flowers
Rosemary	*Rosmarinus officinalis*	Leaves
Tuberose	*Polianthes tuberosa*	Flowers
Vanilla	*Vanilla planifolia*	Beans
Violet	*Viola odorata*	Flowers

PRESENTATION OF ORCHIDS TO THE QUEEN OF BELGIUM

During her visit to St. Louis, October 21, her Majesty, Queen Elizabeth of Belgium, was presented with a basket of orchids by the trustees of the Garden, which, on account of the extremely rare types in the Garden collection, surpassed anything of its kind in the country. Included in the basket were slipper orchids from the famous Brownhurst collection donated by Mr. D. S. Brown in 1918, and two unusual species from Siam, *Paphiopedilum callosum* and its greenish variety *Brownae*. Of especial interest was the Thibet orchid, *P. Fairieanum*, which was lost to cultivation for a number of years and rediscovered by an officer of the British expedition in the Thibet region. Sanders & Sons, orchid specialists of England, valued this orchid so highly as to offer $5,000 for its reintroduction. The basket contained two hundred flowers representing ten genera and thirty-nine varieties, as included in the following list:

Paphiopedilum Actaeus, G. H.*
Paphiopedilum Arthurianum, G. H.
Paphiopedilum Bruno, G. H.
Paphiopedilum callosum, Siam
Paphiopedilum callosum Brownae, Siam
Paphiopedilum Clarkii, G. H.
Paphiopedilum Crossianum, G. H.
Paphiopedilum Elsie, G. H.
Paphiopedilum Creon, G. H.
Paphiopedilum Fairieanum, Thibet
Paphiopedilum Harrisianum, G. H.
Paphiopedilum illustre, G. H.
Paphiopedilum insigne, northern India
Paphiopedilum insigne Dorothy, northern India
Paphiopedilum insigne Sanderae, northern India

*G. H.=Garden hybrid.

Paphiopedilum Matthewsii, G. H.*
Paphiopedilum tonsum, Sumatra
Paphiopedilum Spicerianum, Assam
Cattleya Daphne, G. H.
Cattleya labiata, Brazil
Cattleya Lueddemanniana, Venezuela
Cattleya maxima, Peru
Cattleya Minnie, G. H.
Cattleya Percivaliana, Venezuela
Cattleya Trianae, Colombia
Brassocattleya Hyeae, G. H.
Laeliocattleya Leoniae, G. H.
Laeliocattleya Lucasiana, G. H.
Laeliocattleya Gottiana, G. H.
Laelia Perrinii, Brazil
Dendrobium bigibbum, Australia
Dendrobium formosum giganteum, Khasia hills
Dendrobium Phalaenopsis, Australia
Oncidium Papilio, West Indies
Oncidium varicosum Rogersii, Brazil
Phalaenopsis Esmeralda, China
Stenoglottis longifolia, South Africa
Epidendrum auritum, Mexico
Epidendrum ciliare, Mexico

*G. H.=Garden hybrid.

NOTES

A party consisting of twenty-two delegates to the annual convention of Iron and Steel Electrical Engineers visited the Garden, September 23, and were shown about by special guides.

Dr. B. M. Duggar, Physiologist to the Garden, was appointed a member of the "Planning Committee" for the division of biology and agriculture affiliating with the National Research Council.

Dr. B. M. Duggar, Physiologist to the Garden, spent the summer, upon invitation of the Director of Botanical Research, in scientific work at the Coastal Laboratory of the Carnegie Institution of Washington, Carmel, California.

On his arrival in St. Louis his eminence, Cardinal Mercier, was presented by the Director and Trustees of the Garden with a handsome bouquet containing some twenty varieties of orchids intermixed with spathe flowers.

The School for Gardening of the Missouri Botanical Garden, which was suspended last year on account of war conditions, reopened in September, and scholarships were awarded to Mr. James Monteith and Miss Virginia McMath of St. Louis, and Mr. Robert Mitchell, of Gotha, Florida.

The following lectures were given by Dr. Duggar during the summer: "Research Work at the Missouri Botanical Gar-

den and Shaw School of Botany,'' before the Synapsis Club of the Graduate School of Subtropical Agriculture, Riverside, California, June 18; ''Salt Requirements and Hydrogen Ion Concentration in Solution Cultures for Seed Plants,'' before the Pacific section of the American Association for the Advancement of Science, Pasadena, California, June 21; ''The Importance of an Emphasis upon Research under Existing Conditions,'' before the Science Club of the Utah Agricultural College, Logan, September 18.

Recent visitors to the Garden include the following: Dr. E. S. Moberg, of the University of North Dakota; Dr. A. G. Johnson, Office of Cereal Disease Investigations, U. S. Department of Agriculture; Dr. A. D. Cotton, Mycologist, Royal Botanic Gardens, Kew, England; Prof. R. Koketsu, Plant Physiologist, Imperial University of Kyushu, Japan, and Mr. Kakugoro Nakata, of Kyushu Imperial University, Japan; Mr. A. H. Cockayne, Government Biologist, Department of Agriculture, Wellington, New Zealand; Prof. Frederick Dunlap, Professor of Forestry, University of Missouri; Mr. S. M. McMurran, In Charge of Nut Disease Investigations, U. S. Department of Agriculture; Dr. Hermann Escher, Direktor der Zentralbibliothek, Zurich, Switzerland.

The Rufus J. Lackland fellowships for the year 1919-20 have been awarded as follows:

Mr. W. H. Chambers, B.S. and M.S. University of Illinois.

Mr. G. M. Armstrong, B.S. Clemson College, M.A. University of Wisconsin.

Mr. F. S. Wolpert, A.B. University of Montana.

Mr. E. B. Payson, B.A. University of Wyoming.

C. R. Hursh, B.S. University of Missouri.

Other appointments include the following:

Mr. R. W. Webb, B.S. Clemson College, M.A. Washington University, research assistant; Miss Joanne L. Karrer, B.S. and M.S. University of Washington, and Mrs. Adele L. Grant, B.S. University of California, teaching fellows in the Henry Shaw School of Botany of Washington University, reappointed second year.

Of the former graduate students, research fellows, and assistants in the graduate laboratory, the following have recently accepted new positions: Miss Anne W. Davis, as Chemist, Eastman Kodak Co., Rochester, New York; Dr. A. R. Davis, Instructor in Bacteriology and Soil Chemistry, University of California, Berkeley; Dr. C. W. Dodge, Instructor in Plant Physiology, Brown University, Providence, Rhode Island;

Dr. G. L. Foster, Instructor in Biochemistry, University of California; Mr. D. C. Neal, Plant Pathologist, Georgia State Board of Entomology, Thomasville, Georgia; Dr. Henry Schmitz, Assistant Professor in Forestry, University of Idaho, Moscow, Idaho; Mr. J. W. Severy, Instructor in Botany, Oregon Agricultural College, Corvallis, Oregon; Mr. H. C. Young, Pathologist, Virginia Truck Experiment Station, Norfolk, Virginia; Dr. S. M. Zeller, Plant Pathologist, Oregon Agricultural Experiment Station, Corvallis, Oregon.

The third number of Volume 6 of the Annals has recently been issued with the following contents:

"An Edible Garden Hebeloma," E. A. Burt.

"Protomerulius Farlowii Burt, n. sp.," E. A. Burt.

"The Micro-Colorimeter in the Indicator Method of Hydrogen Ion Determination," B. M. Duggar.

"Studies in the Physiology of the Fungi. VIII. Mixed Cultures," S. M. Zeller and Henry Schmitz.

"Studies in the Physiology of the Fungi. IX. Enzyme Action in Armillaria mellea Vahl, Daedalea confragosa (Bolt.) Fr., and Polyporus lucidus (Leys.) Fr.," Henry Schmitz and S. M. Zeller.

"Studies in the Physiology of the Fungi. X. Germination of the Spores of Certain Fungi in Relation to Hydrogen Ion Concentration," R. W. Webb.

"Diastase Activity in Relation to Stage of Development and Carbohydrate Content of the Tuber of Solanum tuberosum," R. A. McGinty.

STATISTICAL INFORMATION FOR JUNE—SEPTEMBER, 1919.

GARDEN ATTENDANCE:

Total number of visitors in June	16,706
Total number of visitors in July	16,871
Total number of visitors in August	21,596
Total number of visitors in September	17,558

PLANT ACCESSIONS:

Total number of plants received as gifts in July	2
Total number of plants and seeds received as gifts in August	24
Total number of plants and seeds received as gifts in September	92
Total number of packets of seeds received in exchange in September	9
Total number of packets of seeds received as gifts in September	1

PLANT DISTRIBUTION:

Total number of plants and seeds distributed as gifts in June	35
Total number of plants and seeds distributed in exchange in June	12
Total number of plants distributed in exchange in September	18

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought in June	5
Total number of books and pamphlets donated in June	85
Total number of books and pamphlets bought in July	33
Total number of books and pamphlets donated in July	250
Total number of books and pamphlets bought in August	14
Total number of books and pamphlets donated in August	128
Total number of books and pamphlets bought in September	7
Total number of books and pamphlets donated inSeptember	67

HERBARIUM ACCESSIONS:

JUNE

By Purchase—

Rev. John Davis—Specimens from Missouri, etc.	500

By Gift—

J. M. Greenman—Plants of Arkansas	3
N. E. Hansen—Cultivated specimen of *Rhipsalis Cassytha* Gaertn.	1
J. M. Jackson—*Magnolia acuminata* L. from northwest Missouri	1
O. S. Ledman—*Delphinium* sp. from Missouri	1
Mrs. C. McNairy—*Sedum pulchellum* Michx. from Arkansas	1
Dr. G. L. Peltier—*Corticium vagum* on *Melilotus alba*	1
Charles Studt—*Sedum pulchellum* Michx. from Missouri	1

JULY

By Purchase—

Canton Christian College—Plants of China	463
Herbert C. Hanson—Plants of Texas	316

By Gift—

Walter H. Aiken—*Nicotiana glauca* Grah. from Texas	1
Prof. E. A. Bessey—*Corticium* on leaves of *Plantago*	1
T. S. Brandegee—*Senecio Deppeanus, S. parasiticus* Hemsl., and *Liaburn andromachioides* Benth. & Hook. f. from Mexico	3
J. A. Drushel—Plants from Vermont, New Jersey, and Missouri	7
Dr. A. H. Graves—*Merulius ambiguus*	1
Dr. J. M. Greenman—Plants of St. Louis Co., Missouri	29
Dr. G. T. Moore—*Dictyophora duplicata*	1
Geo. H. Pring—Cultivated specimen of *Arenga saccharifera* Labill.	1
University of California, by Prof. F. J. Smiley—*Erechtites prenanthoides* DC. from California	1
Prof. A. H. Van Vleet—*Phacelia strictiflora* Gray from Oklahoma	1
S. P. Verner—Plants of Panama	3
Prof. A. Yasuda—Fungi of Japan	20

By Exchange—

New York Botanical Garden—Plants of Colombia, collected by Dr. F. W. Pennell	741
New York Botanical Garden, by Dr. P. A. Rydberg—*Senecio* sp. from Panama	1
Dr. Earl E. Sherff—Photographs of types and authentic specimens of *Bidens* and *Taraxacum*	18

AUGUST

By Gift—

Prof. C. E. Allen—Cultivated specimen of *Incarvillea Delavayi* Bur. & Franch., a native of China	1
Miss Arnott—*Scirpus americanus* Pers. from Jefferson Co., Mo.	1
A. W. Haupt—*Habenaria* sp. and *Potamogeton epihydrus* Raf. from Wisconsin	2
C. O. Heer—Cultivated specimen of *Pyrus Halliana* Hort.	1
A. S. Kalenborn—*Gentiana* sp. from the Andes of Peru	1
Artena M. Ollson—Cultivated specimen of *Justicia* sp.	1
Dr. L. O. Overholts—*Mucronella Ulmi* Peck	1
T. Petch—*Necator decretus*, stage of *Corticium salmonicolor*.	1
Geo. H. Pring—Plants of Missouri	20
Carleton Rea—*Thelephoras* of England	3
Dr. J. R. Weir—Fungi of islands of Guam and Cuba, and of Rocky Mountains	29
F. Weiss—*Tremella reticulata* from Minneapolis, Minn.	1
Dr. S. M. Zeller—Fungi of Oregon	9

By Exchange—

New York Botanical Garden, by Dr. Francis W. Pennell—*Pentstemon* of Colorado	5

SEPTEMBER

By Gift—

Mrs. J. M. Bettis—Plants of Missouri	2
C. W. Campbell—*Eupatorium serotinum* Mx. from Illinois	1
E. H. Cole—Cultivated specimen of *Polygonum orientale* L.	1
Geo. M. Darrow—*Calostoma cinnabarinum* from Massachusetts	1
Mrs. Adele Lewis Grant—*Mimulus leptaleus* Gray from California	1
Dr. J. M. Greenman—Plants of Jefferson Co., Missouri	28
H. S. McHenry—Cultivated specimen of *Ipomoea purpurea* var. *alba* with double flowers	1
J. C. Nelson—*Senecio* from Oregon	11
Prof. A. Yasuda—Fungi of Japan	15
Dr. S. M. Zeller—Fungi of Oregon	8

By Exchange—

Edwin B. Payson—Plants of Colorado	62
Philadelphia Academy of Natural Sciences, by Dr. Stewardson Brown	966
Total	3,284

The Garden is open to the public every day in the year, except New Year's, Fourth of July, Labor Day, and Christmas—week days from 8:00 A. M. until one-half hour after sunset; Sundays from December to April, 1:00 P. M. until sunset, from April to December, 2:00 P. M. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Boulevard, on the Vandeventer Avenue car line. Transfer south from all intersecting lines.

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Missouri Botanical Garden Bulletin

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EGYPTIAN PAPER PLANT

One of the most popular aquatic plants in the Garden collection is the *Cyperus Papyrus*, commonly called the Egyptian paper plant, since it was one of the first plants used by the ancient Egyptians in the manufacture of paper. The species which affords the material used for writing purposes is of genuine African origin, establishing itself in marsh lands and in sluggishly flowing water. It is also found in the southern part of western Asia and Syria, on the shores of the Jordan, the lake of Tiberias, and in certain localities in Sicily. At the time of construction of the pyramids the papyrus must have been utilized, for it is represented by hieroglyphic inscriptions of book rolls prepared from the pith. Other monuments dating from the time of the Pharaohs frequently show attempts to reproduce the luxuriant growth of papyrus thickets combined with the diversified fauna of the region.

Up to the sixth century the papyrus was still used for writing material and was a source of wealth to the Egyptians. Upon the advent of the parchment, however, the cultivation of papyrus was abandoned, the ground gradually being more profitably employed until finally the last plant disappeared from the cultivated area in the upper Nile region. At the present time in order to see natural papyrus banks one must ascend the Nile to Khartoum and follow up the White Nile where island clusters rise to a height of over fifteen feet, forming impenetrable thickets of mop-like foliage and producing such luxuriant growth as to obstruct the flow of the river in many places. According to Stanley and others, the region of Victoria Nyanza is occupied by enormous forests of papyrus, particularly in the shallow places of the Sobart.

The word paper is directly derived from papyrus, and the word Bible from biblyos, the Greek name of the papyrus plant. During the period of the Byzantine empire papyrus was used in the copying of legal works. The statement of the time of the court sitting was glued on the report of the prose-

cution, the witness's testimony, or the notary's documents, hence the word protocol, signifying glued.

According to Pliny, single sheets of papyrus were prepared from strips of the pith, one strip being laid vertically and the second glued horizontally above. The lay of the fibers, even up to the present day, is easy to distinguish. The adhesive material was made from a paste of flour and hot water, and in some cases vinegar. Reference is also made to the use of white bread soaked in hot water. After being glued the edges were cut smooth and pressed while still wet, the strips then beaten with a hammer, and again fastened together with an adhesive substance. The piece was then placed under a press to free it from unevenness and finally beaten or hammered and placed in the sun to dry. After the rough or uneven places had been smoothed out with a tooth or shell it was considered a finished product.

The manufacture of the book, or more correctly the roll, was accomplished by gluing the prepared leaves together. The best leaves were used first, then those of inferior type, and finally the poorest ones. This is explained more fully by Birt: "The best leaves were also the most durable and were placed at the end, because, when rolled up, these first leaves came on the outside of the roll and were, in consequence, more exposed to tearing, dampness, or any other injury." The first requirements of good paper (charta) are, according to Pliny, tenuitas, densitas, candor, levor—that is, thinness, density, brilliancy and smoothness.

Some noteworthy fragments of papyrus manuscripts were discovered in later years when the papier-mache mummy cases were taken apart, this Egyptian pasteboard being found to consist of numerous layers of papyrus glued together.

Culture.—Naturally the aquatic plant is a very rank grower, establishing itself readily under artificial conditions and, like the common umbrella plant, growing either as an aquatic or semiaquatic. The seeds should be sowed in early spring in sandy soil and sparsely covered with finely sieved soil. The pots should then be placed in pans of water to prevent the soil from drying and the tops of the pots covered with glass until the seeds have germinated. Being purely tropical in habit, a minimum temperature of 50° F. should be maintained. The seedlings should be pricked off when convenient size to handle and shifted into small pots, later being transplanted to larger pots according to increase of growth. During the latter part of May or early June they

may be planted outside in shallow ponds. The plants should be dug in the fall before frost and divided into small sections for potting and storage in the greenhouse. Copious quantities of water should be given at this time so as to gradually readjust them to semi-aquatic conditions.

TROPICAL FRUIT HOUSE

The popularity of the tropical fruits grown in the economic house has necessitated a decided increase in the collection. The varied industries house has therefore been entirely replanted with both the common and rarer varieties of fruits grown in Florida and California. Their concentration in a special house should afford excellent opportunity for visitors to study the habit of growth and flowering and fruiting periods of these fruits not ordinarily seen outside of the tropics.

In view of the fact that especial interest is usually shown in the citrus plants a collection of standard varieties is planted in the fruit house, including orange, lemon, lime, pomelo and kumquat. These plants were especially grown in Florida for the Garden, being twelve-months-old stock budded upon the sour orange stock *Citrus trifoliata*. This species is the hardiest type known in this country—in fact, it is hardy as far north as Washington, D. C., and is reported to withstand zero weather. It is chiefly used as a stock plant for the budding of various varieties, the fruits being of excellent quality and ripening several weeks in advance of those on their own roots. It is considered the only stock for the popular Satsuma orange, due to its influence upon the hardiness, quality and quantity of the fruit.

A recent introduction of two new species of oranges by E. H. Wilson from China has been secured for the Garden from the Arnold Arboretum. These interesting species were collected in the highlands of southwest China at an elevation of 2000 to 5000 feet. They are not closely related to the other known species of the genus Citrus, and are the northernmost evergreen representatives of the Citrus group. Their introduction was purely for breeding purposes to further improve the hardiness of the orange and lemon. The plants are small trees, with long, slender spines and narrow leaves. The fruit is acid and of good flavor, and the seeds are rather large compared with other varieties.

A noteworthy specimen of the ponderosa lemon is at the present time bearing many well-developed fruits. This is the

largest of any type, the fruits weighing from one and a half to two pounds. It is occasionally grown as a house plant for ornamental use.

PLANTS GROWN IN TROPICAL FRUIT HOUSE

Achras Sapota. Sapodilla plum
Heritieria littoralis
Ananas sativus. Pineapple
Bertholletia braziliana. Brazil nut
Brosium Alicastrum. Bread nut
Cacara erosa
Carica Papaya. Papaya
Carissa grandiflora. Natal plum
Catha edulis. Jag plant
Chayota edulis. Chayote
Citrus Aurantifolia. Lime
Citrus Aurantifolia "Tahiti." Tahiti lime tree
Citrus grandis. McCarthy grape fruit
Citrus grandis. Foster's grape fruit
Citrus itchangensis. Itching orange
Citrus Medica. Citron
Citrus mitis. Calamondin orange
Citrus nobilis. King orange
Citrus nobilis deliciosa. Tangerine orange
Citrus sinensis. Pineapple orange
Citrus ponderosa
Cyphomandra betacea. Tree tomato
Dalbergia sp.
Eriobotrya japonica. Loquat
Eugenia Jambos. Rose apple
Eugenia myrtifolia. Australian brush cherry
Ficus Carica. Fig.
Feijoa Sellowiana. Pineapple guava
Fortunella crassifolia. Meiwa kumquat
Fortunella margarita. Nagami kumquat
Garcinia Mangostana. Mangosteen
Garcinia xanthochymus
Inga edulis
Kigelia pinnata
Litchi chinensis. Litchii
Lucuma mammosa. Marmalade plum
Mangifera indica Tatarifera. Mango
Mangifera sp. Haden's mango
Melicocca bijuga. Spanish lime
Murraya exotica. Orange jessamine
Myrciaria cauliflora
Nephelium Longana
Persea gratissima (sharpless). Avocado
Persea gratissima "El Ora". Avocado
Persea gratissima. "El Fuerte". Avocado
Punica granatum. Pomegranate
Rhizophora Mangle
Schinus terebinthifolius
Spondias tuberosa
Ziziphus Jujuba
Wrightia tomentosa

FEIJOA SELLOWIANA

This ornamental shrub, commonly called the pineapple guava, is of recent introduction in the United States although it has been known to Europeans for over thirty years. It was first collected in South America by Dr. Edouard Andre, who planted it in his garden at Villa Colombia, on the Riviera, and succeeded in developing its first fruits in 1897. In 1891 Dr. F. Franceshi, of Santa Barbara, obtained a stock from Andre and brought about the original introduction in California. As a commercial fruit it is becoming popular in Florida and California. At Gotha, Florida, plants have been grown since 1911 by Mr. H. Nehrling, and at Miami by the United States Department of Agriculture.

The fruit is about the size of a walnut, glossy green, and slightly fragrant when ripe. It is used in jams, jellies, etc., and in combination with the guava is excellent in preserves. In England its cultivation is not successful, according to the Gardeners' Chronicle, but it is useful as an ornamental pot plant. The specimen in the economic house has bloomed profusely but has not produced fruit.

PAPAYA (CARICA PAPAYA)

The papaya is a popular breakfast fruit for both rich and poor in Hawaii, and with the exception of the banana is about the only fruit which enters into the daily diet of the people. Due to the large quantity of papain contained, an enzyme which aids in digestion, it is extremely wholesome and large quantities may be eaten.

The plant grows to a height of twenty feet, bearing large palmate, seven-lobed leaves often measuring two feet across. The fruit varies in size up to fifteen pounds, forty or fifty being borne on a tree. The flesh is salmon-pink to yellow, somewhat resembling a muskmelon. Nearly all parts of the plant are credited with some medicinal value. The seeds possess anthelmintic and carminative properties, the bark is used in the manufacture of rope, and the roots afford a nerve tonic. The most important medicinal property is contained in the milky juice which furnishes the papain of commerce. This is obtained by cutting or slashing the fruit and allowing the juice collected to evaporate to a granular condition. In this crude form it brings a market price of four to eight dollars a pound. The leaves and juice are used to render tough meat tender. This is accomplished by wrapping the meat in the leaves over night, by rubbing a slice of the green fruit

over the flesh, or by dipping the meat in a solution of the juice for a few minutes.

The specimen of the papaya in the economic house has borne over two dozen fruits in the last two years.

MANGO (MANGIFERA INDICA)

While the cultivation of the mango dates from earliest antiquity in India, the last two centuries have seen it extensively grown in other tropical regions. It enters into the diet of millions of people and is termed the king of tropical fruits or the apple of the tropics. The great Mogul Akbar, in the sixteenth century, planted the famous Lakh Bagh, an orchard containing 100,000 plants, some of which are still growing. Careful breeding and selection have resulted in many different forms perpetuated through the medium of inarching or grafting by approach. Some trees attain a height of seventy feet, producing an abundance of fruit valued at 150 dollars a ton.

The resemblance of the mild and even climate of Saharanpur, where mangos thrive, to that of California and Florida suggested to government explorers the possibility of mango cultivation in this country. The introduction into the United States is of recent origin, probably about 1880, when Jacob Miller, of Hollywood, California, received seeds from Guatemala City. The plant raised has had the advantage of a particularly mild location and has developed into a large tree without having been cut back by the frost. An abundance of fruit has been borne, which, however, is of little value due to being produced from a seedling tree. More recently the mango has been cultivated in southern Florida where climatic conditions are more favorable than California. The most extensive groves are at Miami, where, during 1901, experiments were carried out successfully in budding selected varieties for perpetuation. Mangos are now shipped to New York, Chicago and St. Louis, from Florida. The individual fruits are wrapped in tissue paper and packed with excelsior six in a basket. These are subsequently crated, six baskets to a crate. They are usually shipped during late July and August.

The large plants growing in the economic house are of the seedling type, rarely producing fruit. The budded stock lately introduced in the tropical fruit house, however, will undoubtedly bear fruit after becoming established.

AVOCADO (PERSEA GRATISSIMA)

The avocado has been grown in Mexico for several centuries, as many as 2000 to 3000 fruits often being produced annually from a single tree. However, these are of the seedling type and of very little value commercially. The fruit varies with the variety, but generally it is about the shape and size of a pear and sometimes bears the misleading name of alligator pear.

Within the last twenty years plant breeders of Florida and California have given systematic attention to the improvement of the avocado. Previous to 1900 propagation was entirely through seed, which resulted in inferior fruit similar to that of the Mexican type. Since that date propagation has been effected by budding, using selected and varied varieties. One of the earliest orchards from budded stock was planted by Mr. S. B. Bliss, of Miami, Florida, and consists of twenty acres of the Trapp variety. The first marketable crop was shipped about 1910. A good yield of the type is between two to three hundred fruits annually for a medium-sized tree.

The fruit of selected varieties varies from one to six inches in diameter and from several ounces to three or four pounds in weight. In shape it ranges from spherical to slender pyriform. The skin is similar to that of the apple in thickness, is occasionally soft and pliable, and sometimes coarse granular and woody, suggesting a shell ⅛ inch thick. The fleshy inner portion is a mass of yellowish pulp of the consistency of butter and of a nutty flavor. The avocado is different from other fruits, due to its high percentage of vegetable oil, reaching 18 per cent. It is therefore considered more as a food than a dessert.

In commercial use the fruit is selected that has uniformity in shape, the round or oval type being easier to pack than the pear or bottle-shaped varieties. The ideal skin should be thick enough to withstand handling in packing and shipping. Flavor and quality are of course important factors.

The largest plant in the economic house reaches the roof, being thirty feet in height. It is a representative of the seedling type.

CHAYOTE (CHAYOTA EDULIS)

The chayote is a strong climbing plant or vine somewhat resembling the common cucumber in growth, although the vines are far more rampant. It is readily killed by frost but is reported hardy as far north as South Carolina, provided the

roots are protected by a heavy mulch of stable manure. The new growth starts up just as soon as warm weather sets in, producing favorable crops of fruit for several years.

The fruit is somewhat corrugated and varies according to the type between linear and broadly pear-shaped. The color also varies from white to a light green. The chayote is esteemed as a vegetable similar to the squash or the vegetable marrow. It may be stuffed and baked, creamed, or fried with butter as fritters. It also forms a palatable salad with mayonnaise dressing, and when made into sauce it is strikingly similar to apple sauce. In the tropics the large tuberous root is used as food in a similar manner to the well-known yams.

The Garden specimen of the chayote, previous to its removal to the tropical fruit house, bore numerous fruits showing the usual factor of germination while attached to the parent vine.

CHERIMOYA (ANNONA CHERIMOLA)

The fruit obtained from the present-day selected and budded varieties of cherimoya is sometimes called one of the three finest fruits of the world, the other two being the pineapple and the mangosteen. When thoroughly chilled there are few fruits to equal it as a dessert.

The genus is native to the Andes of Peru and adjacent region. At a very early date it was introduced into Central America and Mexico, where it became naturalized. It was probably brought into California in 1871 by the late Judge R. B. Ord, of Santa Barbara. Since this introduction numerous seedlings have been raised and planted in the vicinity, the atmospheric conditions and the soil of Hollywood, especially along the slopes of the valley west, being unusually suited to their cultivation. One of the largest groves is owned by C. P. Taft and consists of about 100 plants.

In Madeira the cherimoya has supplanted the grape vine, particularly on the estates of the southern slopes of the island. Here the cultivation is decidedly systematic, two-year-old budded or grafted stock being used, and plants usually trained upon trellises or walls to enable the fruit to hang in the shade during ripening.

The cherimoya grows to a height of fifteen to twenty feet. The flowers are remarkably uniform, but vary somewhat in size. The fruit varies considerably in shape and appearance,

sometimes conical and sometimes heart-shaped or ovoid, the surface being covered with concave U-shaped areoles, each of which bears a small wart or tubercle. The favorite commercial type of California is called the Golden Russet. This is pear-shaped in outline, with small wart-like tubercles near the rounded apex of the areole. Through careful selection varieties of fine flavor with very few seeds may now be obtained, the fruit weighing from twelve to sixteen pounds. According to Fawcett, ordinary fruits weighing from three to eight pounds have sold in the London markets at one dollar and a half, the larger ones at two and a half to three dollars.

MANGOSTEEN (GARCINIA MANGOSTANA)

The mangosteen is native of the Malay region. It is a handsome tree twenty-five to thirty feet in height, bearing dense dark green foliage resembling the rubber tree. Its growth is very slow and fruit is not produced for eight to nine years from the seedling stage. In Ceylon the trees flower twice a year, first in August, the fruit ripening in January, and again in January, the fruit ripening in July and August. According to Wright, the January crop yields but 100 fruits to a tree while the August crop yields 500 to 600 fruits to a tree.

The fruit is particularly striking in view of the persistent large leathery light green calyx lobes. It is indescribably delicious in flavor and has been called the "queen of the fruits." The late Queen Victoria valued it so highly as to offer a prize for its first introduction into England from India. The fruit is about the size of a Mandarin orange, round and slightly flattened at each end, with a smooth thick rind, rich purple in color sparsely spotted by hardened drops of the yellow juice. Apparently there is nothing to mar the perfection of the mangosteen unless it is that of the juice of the rind which leaves an objectionable indelible stain.

In the Dutch East Indies the fruit is offered for sale heaped upon baskets or made in long regular bunches braided together with thin strips of bamboo. Upon opening the fruit the coloration and beauty of the individual segments of the pulp attract attention. These five to seven segments, separated by snow-white partitions, are somewhat loosely attached to the rind similarly to the Mandarin orange but covered with a network of delicate fibers. The sides of the segments are translucent and slightly tinged with pale green.

The texture of the fruit is extremely delicate, suggesting that of a well-ripened plum.

Repeated attempts, up to the present time, to introduce and establish the mangosteen into California and Florida have failed. An importation from Ceylon was received at the Missouri Botanical Garden in 1913, and specimens were planted in the economic and varied industries houses, but without success. The plants grown in the private greenhouse are still growing. Seeds of *Garcinia xanthochymus* were imported from Ceylon and the seedlings raised will be used for inarching the mangosteen. This species is a much stronger plant, adapting itself to various types of soils, and is advocated as an excellent variety for the mangosteen stock. With the successful union of these species there is a possibility of fruiting the mangosteen in the tropical fruit house at the Garden.

NOTES

Mr. L. E. Miles, of the University of Illinois, consulted the mycological herbarium of the Garden, November 28.

Dr. George T. Moore, Director of the Garden, addressed the science section of the Missouri Teachers' Association, at Central High School, November 7, on "The Missouri Botanical Garden as an Educational Institution."

Dr. D. T. MacDougal, Director of Botanical Research, Carnegie Institution of Washington, spent a day at the Garden recently in connection with the arrangements for the meetings of the American Association for the Advancement of Science and affiliated societies, in December.

Mr. G. H. Pring, Floriculturist to the Garden, gave a stereopticon lecture on "The Cultivation of the Cultivated Chrysanthemum" before the St. Louis Association of Gardeners, November 5.

STATISTICAL INFORMATION FOR OCTOBER, 1919.

GARDEN ATTENDANCE:

Total number of visitors.....14,161

PLANT ACCESSIONS:

Total number of plants and seeds received as gifts..... 2,226

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought.....	28
Total number of books and pamphlets donated.....	81

HERBARIUM ACCESSIONS:

By Purchase—

F. S. Collins—"Phycotheca Boreali-Americana." Fase. XLVI, Nos. 2251-2300.....	50

By Gift—

P. J. Anderson—*Stereum Burtianum* Peck.....	1
E. A. Bessey—Fungi of Gogebic County, Michigan.....	116
E. Bethel, by E. B. Payson—Plants of Oklahoma.....	3
Mrs. Adele Lewis Grant—Plants of California.....	9
T. S. Brandegee—*Exothea Copalillo* Radlk. from Mexico	1
H. D. House—*Merulius terrestris* (Pk.) Burt.....	1
L. P. Jensen—White-flowered form of *Verbena hastata* L.	1
E. O. Matthews—*Pleurotus ostreatus* from Texas.....	1
F. L. Stevens—Fungi of Porto Rico.....	124
H. von Schrenk—*Peniophora gigantea*, on railway ties in Arkansas	1

By Exchange—

New York Botanical Garden, by Marshall A. Howe—Hepatics and mosses from various localities.....	195
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The Garden is open to the public every day in the year, except New Year's, Fourth of July, Labor Day, and Christmas—week days from 8:00 A. M. until one-half hour after sunset; Sundays from December to April, 1:00 P. M. until sunset, from April to December, 2:00 P. M. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Boulevard, on the Vandeventer Avenue car line. Transfer south from all intersecting lines.

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MISSOURI BOTANICAL GARDEN BULLETIN

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SUGAR PALM

The Garden is in possession of a noteworthy specimen of sugar palm (*Arenga saccharifera*), donated by the late Mr. D. S. Brown in 1913 from his collection at Brownhurst, Kirkwood, Mo., and planted in the new conservatories (see October, 1913, number of BULLETIN). When transplanted the young terminal leaf was half grown, but after full development the center began to show an unusual crowding of the pinnae, which indicated that a check had been administered through transplanting. The plant remained dormant approximately one year, but during the last five years it has shown considerable activity in growth, the trunk increasing from six to seventeen feet in height and from two feet to two feet eight inches in diameter. It has produced fourteen new leaves since 1914, the last removed being the one showing the check through transplanting.

The flowering habit of this palm is so irregular as to suggest a differentiation into various types and forms. According to Simmonds in "Tropical Agriculture," the uppermost spikes open their flowers first, those lower down next, until the last one is produced near the base of the trunk. The first three spikes of the Garden specimen (see Vol. 7, pl. 14 of BULLETIN) were abortive, the staminate flowers developing to about half the normal size, then dropping off. When examined no trace of stamens was evident, the central or pistillate flowers being persistent for several weeks and showing considerable growth, but subsequently falling off. The plant has now produced five large racemes, the first three composed of green, nut-like abortive flowers, while the two basal spikes contained very showy, perfect staminate yellow flowers, the entire structure presenting such an unusual appearance as to call forth many inquiries from visitors.

Owing to a shortage of sugar during the war the attention of investigators was directed towards the discovery and introduction of newer types of sugar-producing plants. Palm

sugar has been collected by the natives of the Philippines, Malaya, and India for local consumption for many years, but the yield was not regarded as sufficient for commercial purposes. Investigation soon demonstrated, however, that a deplorable waste of material in palm sugars was largely responsible for the inadequate results obtained from the crops of the tropics. India now is increasing its production of sugar from the extensive semi-cultivated groves of the wild date (*Phoenix sylvestris*) of Bengal and the palmyra (*Borassus flabelliformis*) of southern India and Ceylon. The United States Department of Agriculture stations in the Philippines are experimenting with four well-known palms, which, with the use of modern machinery, ought to increase greatly the production of sugar. The cocoanut palm (*Cocos nucifera*) will produce sugar, but its present economic product of copra is too valuable to be replaced by anything else.

The "kaong" or sugar palm in the Cavite province of the Philippine Islands begins to flower in six years, providing the tree has plenty of room for development. It is not strictly a jungle species, but prefers the banks of mountain streams, margins of forests, and partially open hillsides. The fiber which surrounds the trunk is a soft, shining, brownish black substance mixed with masses of strong needle-like spines. The presence of this fiber is responsible for the plant's local Spanish name "cabonegro" or "blackhead." Economically, this inner fiber is valued in commerce for rope-making because of its resistance to salt water, withstanding alternate wetting and drying or continued exposure, and is superior to any other fiber. It is known in commerce as "gamuti" or "eju." The seeds when fully matured are occasionally used in desserts, being prepared by boiling in sugar and adding spices or other flavoring substances. The outer pulp-like covering, or pericarp, enclosing the three hard-shelled seeds, contains needle-like irritating crystals which cause severe itching when brought in contact with the skin. Both bats and wild pigs feed upon the yellow fruits.

COLLECTION OF SAP FOR SUGAR

The natives usually follow traditional customs in tapping and managing the flower spikes. Only the male spikes are selected for sap collection, and after these are "spotted" they are "beaten" or "pulled" mornings and evenings for a period of three weeks. This is accomplished by jerking the spikes when low enough, or when high tying to them long strips of bamboo to enable the tapper to perform this jerking

or pulling operation from the ground. This primary operation, according to the natives, influences a greater flow of sap into the peduncle or flower spike.

When the flowers have opened an incision is made in the upper portion of the spike close to the first pedicels. In common practice the end of the cut stem is thoroughly rubbed with crushed fruits of the wild pepper (*Capsicum frutescens*), as this is supposed to increase the flow of the sap. The cut end is then wrapped with banana leaves to keep it from drying out, this covering usually being left on from two to three days until the flow of sap begins. Occasionally, the sap will exude the first or second day, but it is three days before the quantity is sufficient to allow collection. The maximum flow in most cases is usually attained during the first three weeks after tapping. However, variations due to temperature, rainfall, etc., may influence the flow and the time at which the maximum is attained. It is also observed that, due to mismanagement, the flow will stop suddenly, while under expert care it may last from eight to ten weeks.

The method of collecting the sap is by means of a "panahod," a water-tight receptacle consisting of a section of a large bamboo cut just below the node. This is suspended from the flower spike immediately below the incision. A slit is also made on the under side of the cut end of the peduncle to prevent the sap from flowing back toward the trunk of the tree. The panahods are usually collected mornings and evenings, fresh receptacles being used each time in order to prevent the action of certain wild yeasts which cause fermentation. At the time of collection the tapper also removes a thin slice from the stem, again rubbing the exposed portion with pepper fruits to increase the flow. When the flow reaches the point of unprofitable yield a wad of burning fiber is held against the stem so as to dry up the tissue and stop any further leakage. Trees that are under cultivation will flow from two to three months, producing on an average of 2½ to 3 gallons a day, this yield usually diminishing to about ½ gallon at the end of 2½ months. According to O. W. Barrett, it appears probable that one hectare (2.47 acres) containing not less than 150, and not more than 200 trees should produce under modern culture methods some 20 or more tons of marketable sugar per year over a period of 10 to 15 years. This yield, considering the extremely low upkeep, compares very favorably with that of the very best cane sugar plantations.

VINEGAR AND STARCH PRODUCTION

In the Cavite province of the Philippine Islands the "kaong" sap is converted into vinegar . One quart of the sap with proper oxidation will give approximately 1.8 quarts of 4 per cent vinegar. The sap is collected in the same manner as for sugar except that the panahods are not gathered as often nor is there any effort made to prevent fermentation upon collection.

For starch production the Philippine farmer selects the so-called "males," these being the semi-sterile types which in most cases produce only the abortive female flowers. This type is evidently never fertile and consequently never produces mature fruit, the flowers usually dropping off in the form of hard, hollow shells. (The first three spikes produced upon the garden plant were of this kind.) These spikes are usually cut off as soon as they appear, so as to retain the valuable material in the trunk, which otherwise may deteriorate.

To test the degree of ripeness for starch it is customary to chop a deep notch at the base of the trunk. If the tree is ready it is chopped close to the ground. The main part of the trunk is then cut into blocks which are again cut into smaller pieces and pounded in a wooden or stone mortar until reduced to a fine meal. This is then placed in vats and washed thoroughly to separate the starch grains. In order to further purify the starch it is subjected to various changes of water, and, being heavier than the impurities, it readily settles to the bottom. It is then collected and after being dried in the sun is ready for market. The remaining residue is boiled to a thick gruel and used as food for hogs.

HEDGES

The clipped, formal hedges are a common sight in St. Louis, being used to separate one small lawn from another and to lend a certain amount of seclusion. The unity and the harmonious effect of the whole street is lost, however, by this chopping up of the greensward into small individual patches, and the hedge in the city might better be confined to the larger lawns and to back-yards, where a live fence is much more attractive and quite as serviceable as the dilapidated wooden structure usually seen. Upon larger places the beauty of the hedge is not always manifested by its straight lines, as often a certain distinction is added to the landscape by the variety of form which it is possible to inject into hedge planting.

The prevalent use of California privet (*Ligustrum ovalifolium*) in St. Louis has led to the belief that it is the only hedge plant for this vicinity. While its quick growth, ease of upkeep, and adaptability to any desired shape has been responsible for this popularity, there are many other plants quite as practical and under some conditions more desirable. Almost any of our best-known shrubs are equally ornamental and serviceable when used to divide gardens, outline drives, or provide seclusion.

The following table indicates the hedge plants which have been tried out at the Garden:

Botanical Name	Common Name	Height	Manner of Treatment
Aralia pentaphylla	Aralia	Medium	Informal
Berberis Thunbergii	Japanese barberry	Low	Formal
Berberis Thunbergii nana	Box barberry	Low	Formal
Cornus stolonifera	Dogwood	Tall	Informal
Crataegus Oxyacantha	English haw	Tall	Formal
Cydonia japonica	Japanese quince	Medium	Formal
Diervilla floribunda	Weigelia	Medium	Informal
Deutzia crenata	Deutzia	Tall	Informal
Elaeagnus longipes	Gumi	Tall	Formal
Exochorda grandiflora	Pearl bush	Tall	Informal
Gleditsia triacanthos	Honey locust	Tall	Formal
Hibiscus syriacus	Rose of Sharon	Tall	Informal
Hippophae rhamnoides	Sea buckthorn	Medium	Informal
Ligustrum ovalifolium	California privet	Medium	Formal
Ligustrum ovalifolium aureum	Golden privet	Low	Formal
Ligustrum Ibota	Japanese privet	Medium	Formal
Lonicera tatarica	Honeysuckle	Tall	Informal
Lonicera fragrantissima	Honeysuckle	Tall	Informal
Mahonia Aquifolium	Oregon grape	Low	Informal
Philadelphus grandiflorus	Mock orange	Tall	Informal
Rosa rugosa	Japanese rose	Medium	Informal
Rhamnus cathartica	Buckthorn	Tall	Formal
Spiraea Bumalda var. "A. Waterer"	Spiraea	Low	Informal
Spiraea prunifolia	Bridalwreath	Medium	Informal
Stephanandra flexuosa	Stephanandra	Low	Formal

The best of the formal hedges include the privets: the Japanese barberry, with its compact growth, dense foliage, and brilliant coloring of fruit and foliage in the fall; the stephanandra, resembling the barberry in appearance, and honey locust, English haw, and buckthorn, for taller effects. A recent introduction which promises to become a fine sub-

stitute for the boxwood is the box barberry. For informal effects the honeysuckles, dogwoods, and weigelias are the most satisfactory, possessing desirable foliage and effective blooming qualities.

Since the hedge plants must necessarily be planted closely together to secure compactness of form, proper preparation of the soil is quite essential. It should be mellow, well enriched with manure and retentive of moisture. In planting, a straight trench should be dug in which to set the plants, placing them 2-3 inches deeper than they grew in the nursery. The distance apart in planting varies from 8 inches in the case of low-growing plants to 2 feet for the larger and more vigorous growers. Two-year-old plants are preferable, so as to make a rapid and satisfactory growth during the first year. Severe pruning should be practised at the time of planting to force low branching, the hedge usually being cut back half way or even lower. After planting, a thorough watering should be given and a mulch of leaves, manure, or other material applied to conserve moisture and induce rapid growth. Watering should be continued throughout the first season, and even with the best of care, gaps usually develop in the hedge. These should be filled without fail at the next planting season with larger plants than those originally planted.

During the growing season formal hedges require frequent trimming to retain their compactness of form and exactness of outline. They should not be pruned later than September, otherwise the new growth will not ripen before winter and will be subject to frost injury with a subsequent ragged appearance next season. Oval shaping is the best from the standpoint of plant growth, all parts of the hedge being allowed to grow upwards in a natural manner. However, the preferred style is the flattened top which does fairly well with plants that endure much abuse like the privets. The informal hedges should be given but little pruning, only the very scraggly branches and the old wood being cut out. In their case all pruning should be done after flowering in order not to destroy the beauty at the blooming periods.

CHRISTMAS FLORAL DISPLAY

Visitors to the Garden will welcome the renewal this year of the winter flower shows, which were discontinued during the war, due to the fuel administrator's order to conserve coal. Although the closing of all the growing houses for the

war period resulted in losing a large majority of stock plants necessary to subsequent displays the parent plants which would have been difficult to replace were taken care of in the permanent conservatories. Chief among these were the new types of pink, white, and double poinsettias introduced from Europe before the war. The common red form was allowed to freeze, as it could readily be replaced from American florists' stock.

The Christmas floral display for 1920 will be entirely different from that of previous years. The bright scarlet poinsettias which formerly constituted an important feature of the show will be set aside for the delicate, softer-colored bracts of the new hybrid pink and white types, over a thousand plants having been propagated from the few plants carried over. These are of varied heights, due to the intensive cultivation necessary to obtain sufficient numbers for the exhibit. The tall specimens of eight feet or over were propagated from cuttings obtained from parent plants last March. As the warm weather approached these parent plants were planted outside to further increase their growth that they might furnish a sufficient number of cuttings for the present Christmas display. The dwarf plants in large pots were rooted during the latter part of September. The poinsettias are exhibited in two embankments bordered by the Jerusalem cherries (*Solanum Pseudo-capsicum*). The cyclamens which ordinarily require over twelve months' preparation will not be included in the 1920 display.

ORCHIDS

The donation by the late D. S. Brown of his entire orchid collection to the Garden has necessitated transferring the flowering orchids to the more spacious floral display house. The hundreds of orchids in the Christmas floral display constitute the largest exhibit of epiphytic plants ever staged in St. Louis, comparing well with the large flower shows in the East which are concentrated from several collections.

Mr. Brown's favorite slipper orchids dominate the exhibit. Some of these he personally raised from seeds, over five years being required from the time of pollination to the production of the first flower. One of his hybrids, a soft yellow variety resulting from intercrossing *Paphiopedilum insigne Eirmanianum* with the pollen of *P. nitens Leeanum* he dedicated to his daughter, calling it *Paphiopedilum* "Sidney Brown." Another he named for his orchid grower, J. C. Krumm, who managed the collection up to the time of its

removal to the Garden. The flower of this species is of a purplish and greenish brown color, and strongly resembles the seed parent, *P. hirsutissimum*. The hybrids imported from Europe at fabulous prices are also on exhibition, among which are the albino variety of *P. Harrisianum*, *P. Clarkii*, and *P.* "Priam," the latter having been awarded the first-class certificate by the Royal Horticultural Society of London. Another striking hybrid of early origin is *P. Fitchianum*, strongly resembling the parent, *P. venustum*. The following genera are also represented in the display: Angraecum, Lycaste, Coelogyne, Cattleya, Laeliocattleya, Vanda, Oncidium (butterfly orchid), Calanthe, Polystachya, Maxillaria, and Dendrobium.

STATISTICAL INFORMATION FOR NOVEMBER, 1919.

GARDEN ATTENDANCE:

Total number of visitors.....49,187

PLANT ACCESSIONS:

Total number of plants and seeds received as gifts.... 418

LIBRARY ACCESSIONS:

Total number of books and pamphlets bought..... 34
Total number of books and pamphlets donated..... 87

HERBARIUM ACCESSIONS:

By Purchase—

Pedro Jörgensen—Plants of Argentina..... 551
C. F. Baker—"Fungi Malayana," Cents. IV-V, Nos. 301-500 inclusive 200

By Gift—

A. R. Davis, by B. M. Duggar—Plants of California.... 312
Hessler, L. R.—*Stereum rameale* on cherry limbs..... 1
Miss Norah Jamieson—Cultivated specimen of *Euonymus sp.* 1
C. G. Lloyd—*Rhizopogon sp.*..... 1
W. C. Muenscher—Fungi of Ithaca, N. Y..... 21
S. B. Parish—*Mimulus* from California..... 33
L. H. Pennington—*Clavaria fistulosa* from New York... 1
F. G. Pernond—*Hydnum coralloides*..... 1
H. E. Stork—*Aleurodiscus sp.*..... 6
H. von Schrenk—Fungi of Temagami, Canada..... 16
L. B. Walker—Polypores of Nebraska..... 2

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E. L. Moseley—Plants of Ohio..... 300

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The Garden is open to the public every day in the year, except New Year's, Fourth of July, Labor Day, and Christmas—week days from 8:00 A. M. until one-half hour after sunset; Sundays from December to April, 1:00 P. M. until sunset, from April to December, 2:00 P. M. until sunset.

The main entrance to the Garden is located at Tower Grove Avenue and Flora Boulevard, on the Vandeventer Avenue car line. Transfer south from all intersecting lines.

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STAFF
OF THE MISSOURI BOTANICAL GARDEN

Director,
GEORGE T. MOORE.

BENJAMIN MINGE DUGGAR,
Physiologist in charge of Graduate Laboratory.

JESSE M. GREENMAN,
Curator of Herbarium.

HERMANN VON SCHRENK,
Pathologist.

ROBERT W. WEBB,
Research Assistant.

EDWARD A. BURT,
Mycologist and Librarian.

KATHERINE H. LEIGH,
Secretary to the Director.

NELL C. HORNER,
Editor of Publications.

JAMES GURNEY,
Head Gardener, *Emeritus*.

JOHN NOYES,
Landscape Designer.

G. H. PRING,
Floriculturist.

W. F. LANGAN,
Engineer.

P. FOERSTER,
Farm and Stables.

H. VALLENTINE,
Carpenter.